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Familial Contexts of Mental Impairment in Schoolchildren and Emotion Reactivity in Adolescents with Conduct Disorder

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- Verhaltens- und Emotionale Probleme bei Vorschulkindern im Kontext der Mutter-Kind-Interaktion – zum Einfluss der mütterlichen psychischen Gesundheit
- Maternal Health Problems such as Depression and Anxiety and Parent-Child Interaction
- Psychophysiological Responses to Emotion Induction through Film Clips in Girls and Boys with Conduct Disorder

Basel, 31. Mai 2019

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Content

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Abstract

The emotional climate between mothers and their children and other environmental factors are known to be significant indicators for the development of childhood psychopathology. However, the parent–child relationship can be affected by several psychosocial risk factors, especially maternal mental health. Moreover, there is significant evidence suggesting that most psychopathology in children and adolescents rests upon deficits in their emotion processing. In our study, we accounted for conduct disorder (Beauchaine et al.) as one correlate of deficient emotion processing in adolescent girls and boys.

The participants in our first study were 49 children aged 5-7 and their mothers. The Five-Minute Speech Sample (FMSS) was used to evaluate maternal expressed emotion (EE). Behavioral disorders were assessed with the German version of the Child Behavior Checklist (CBCL 14-18). Psychopathology in mothers was assessed using the German version of the Brief Symptoms Inventory (BSI). The quality of the mother–child interaction was observed during a standardized problem-solving task. In our second study, 927 girls (427 CD, 500 controls) and 519 boys (266 CD, 253 controls) aged 9-18 years participated. Two sad film clips were shown to induce an emotional response. Heart Rate (HR), Respiratory Sinus Arrhythmia (RSA; parasympathetic activity), and Pre-Ejection Period (PEP; sympathetic activity) measured ANS activity. Sex differences were investigated as well as differences in CD subgroups using comorbid internalizing disorders (INT) and the low prosocial emotion specifier (LPE) as grouping variables.

Our first study could add new insights into, and understanding of, the behavioral problems of children. Our results could highlight noteworthy links between a mother's criticism, child psychopathology and mother-child interactional patterns. In the light of our results and in order to improve the treatment of preschool children with mental health problems, it seems to be vital to reduce maternal psychological strain and to improve the quality of mother-child-interactions. The results of our second study showed that CD is characterized by an increased autonomic emotional response, which is most pronounced in CD subjects without LPE. Moreover, results suggested emotion regulation problems in both CD boys and CD girls. However, smoking may be a confounding factor in relation to this association and, thus, requires further investigation.

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Chapter 1 General Introduction

Pathways to children's maladjustment: The role of environmental factors

Besides pre- and perinatal influences such as exposure to harmful substances, maternal infections, maternal distress and poor nutrition during pregnancy (A. S. Brown, 2012; Monk, Georgieff, & Osterholm, 2013; Motlagh et al., 2010), specific factors in children's environments have been identified as risk factors in the development of childhood mental disorders (Shonkoff et al., 2012) and therefore seem to be of relevance in the field of research into child and adolescent psychiatry. Pechtel and Pizzagalli (2011) reviewed the effects of early life stress (ELS) on emotional and cognitive outcomes in children, adolescents and adults, and found ELS to be associated with deficits in a range of cognitive functions (cognitive performance, memory, and executive functioning) and affective functions (reward processing, processing of social and affective stimuli, and emotion regulation).

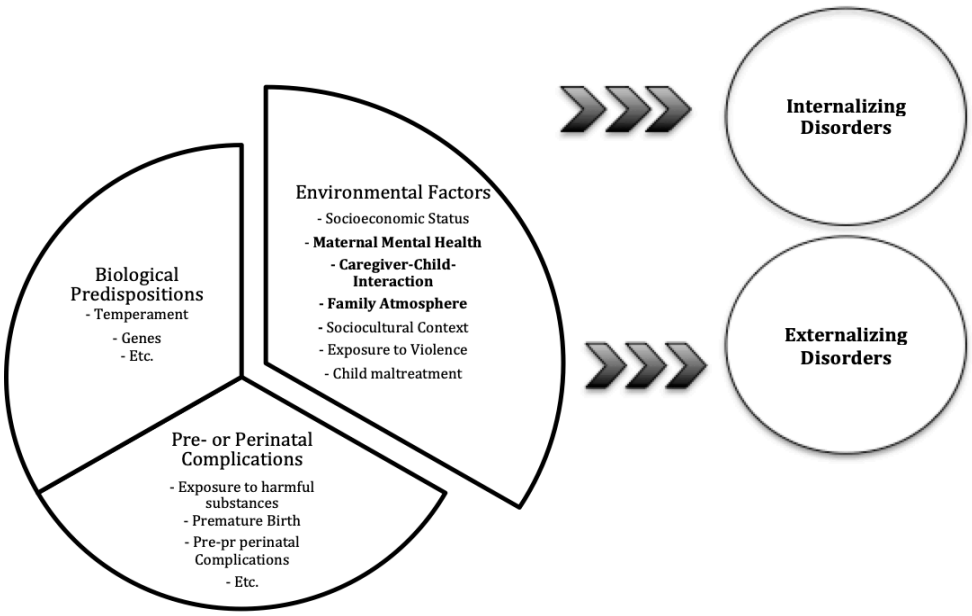

Figure 1. Pathways to the development of child maladjustment.

Similarly, Hughes et al. (2017) investigated the effects of adverse childhood experiences (ACE) on physical

and mental health outcomes, finding no associations or only weak associations between ACEs and physical health, but moderate to strong associations between ACEs and mental health outcomes. ACEs and ELS are defined in a similar manner, both incorporating chronic adverse exposure to events, situations or interactions which harm the healthy development of a child (e.g. low socioeconomic status, domestic violence, emotional neglect, poor parental mental health) (see Figure 1).

In particular, family relationships and patterns of interaction appear to be significant indicators in the development of childhood psychopathology, as they are known to influence genetic factors and are involved in neuronal mechanisms of brain development, including brain structure (Curley, Jensen, Mashoodh, & Champagne, 2011; Weder et al., 2014).

Moreover, a large body of evidence supports the idea that high quality parenting in childhood, characterized by warmth, involvement and sensitivity, predicts a range of positive social-emotional, language development and cognitive outcomes in early and middle childhood (McKee et al., 2007; Shin, Park, Ryu, & Seomun, 2008), as well as children's attachment behavior (Biringen et al., 2005) and overall mental health (Wan et al., 2012).

Using the concept of mother-child mutually responsive orientation (MRO), Kochanska, Forman, Aksan, and Dunbar (2005) found MRO to directly and indirectly influence children's consciences later in development. Particularly, they identified interactional patterns such as a child's enjoyment of interaction and commitment compliance as relevant predictors regarding different domains of the development of children's consciences. Similarly, patterns of co-regulation in mother-child dyads have been found to positively affect children's attachment organization as well as their mental and psychomotor development (Evans & Porter, 2009).

As outlined, harmonious and emotionally supportive parent-child interactional patterns seem to be crucial in healthy child development. Thus, besides children's characteristics, parental factors influencing interactions seem to be of relevance. Indeed, parental mental health has been identified as important in relation to interactional patterns. Kaitz, Maytal, Devor, Bergman, and Mankuta (2010) found maternal anxiety disorder to influence mother-child interactions in a disquieting way, with mothers responding in an exaggerated way to their children compared to a nonclinical sample. Furthermore, there is substantial evidence that especially

maternal depression influences mother-child interaction in a negative way. Lovejoy, Graczyk, O'Hare, and Neuman (2000) found depressed mothers to exhibit more hostility and less emotional display and warmth while interacting with their 3-month-old babies. Moreover, Field (2002) found postpartum depressed mothers to be less responsive to their children's cues.

As mentioned above, parenting practices and thoughts are widely known as risk factors for the development of child mental health problems (Scott, 2012). Bøe et al. (2014) suggested that parental practices represent one factor through which low socioeconomic status is associated with child mental health problems.

Furthermore, Smokowski, Bacallao, Cotter, and Evans (2015) found negative parenting to be significantly associated with increased anxiety, depression and aggression in adolescents, whereas positive, emotionally and practically supportive parenting behavior was associated with increased self-esteem and less mental strain. When reviewing literature, it can be seen that a noticeably large number of research findings highlight the associations between parenting styles and their effect on the development of externalizing disorders in children and adolescents (Gardner, Shaw, Dishion, Burton, & Supplee, 2007; Loeber, Burke, & Pardini, 2009; Trautmann-Villalba, Gschwendt, Schmidt, & Laucht, 2006). Kolko, Dorn, Bukstein, and Burke (2008), for instance, found parental hostility to increase the risk that children with ODD will develop a conduct disorder later on. Similarly, Ramchandani et al. (2013) found unengaged father-child interactions to be predictive for later externalizing behavioral problems in children.

Evaluating mother-child interaction

Measurement tools for the evaluation of child-caregiver interaction are plentiful, consisting of observational tools on the one hand and self-reports on the other hand. Self-reports are susceptible to potential bias from the caregiver's own feelings, thoughts towards the child or need to answer in a socially desirable way (Corcoran & Fischer, 2013), whereas observational tools allow a more objective evaluation of the dyadic interaction, while being more complex and time-consuming instruments. Most tools based on caregiver-child observation refer to three dimensions comprising caregiver qualities, such as sensitivity and emotional availability; child qualities including the child's engagement, responsiveness and involvement; and dyadic qualities of the observed interaction, to evaluate whether there was appropriate coordination between the interaction partners. Lotzin et

al. (2015) meticulously reviewed electronic databases for citations concerning observational tools for measuring parent-infant interaction and identified 24 tools that have been described and psychometrically evaluated in literature and evaluated their validity in five domains. Only ten of them provided evidence in four of those five validity domains (Lotzin et al., 2015). One cited and well-examined method to evaluate the dyadic quality of interaction in stress eliciting tasks is the concept of emotional availability (EA) introduced by Biringen and Robinson (1991) and Biringen et al. (2008). The EA scales stand out from other measures that evaluate mother-child interaction by including two different child dimensions and not only focusing on caregiver qualities when evaluating the quality of interaction. The EA scales are composed of four caregiver qualities: sensitivity, structuring behavior, non-intrusiveness, and non-hostility towards the child. The child dimensions include the amount and quality of responsive behavior by the child towards the caregiver, and involvement of the caregiver in the interaction by the child. Maternal sensitivity is conceptualized as formerly described by Ainsworth (1978) in terms of how well the caregiver perceives the child's emotional states, signals and needs, and in terms of how appropriately and promptly the caregiver reacts to those signals. Hence, sensitivity includes a flexible, competent and appropriate emotional reaction from the caregiver to the child in accordance with a parental emotional holding function. The caregiver's structuring behavior during the interaction is defined as optimal when it is appropriate in its degree of support without constraining the child's autonomy. Parental structuring behavior should offer the amount of guidance during the interaction that is needed for the child to successfully learn and explore, without being harsh, dominant or intrusive. This leads to the third dimension of caregiver behavior, the nonintrusive quality, which assumes a well-balanced availability of the caregiver, without being overprotective or overwhelming. Non-hostility is defined as the appropriate and controlled expression of emotion by the caregiver. Child responsiveness, as the first child dimension, refers to the way the child affectively reacts to the verbal inputs and emotional displays of the caregiver during the interaction to create something like an intersubjective relatedness. The involvement dimension describes the way the child actively involves the caregiver in its play, thoughts and emotions, for example by asking questions, or demonstrating or explaining what they are doing.

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The importance of family affective climate: The concept of expressed emotion

EE is conceptualized as a measure of family members' emotional attitudes, feelings and behaviors toward another family member. It focuses on the level of criticism (EE CRIT) and emotional over involvement (EOI) expressed toward that family member. Family or parental expressed emotion is, according to this, an index of the affective climate within the family. The assumption underlying EE is that the way parents talk about their child is indicative of the way they treat their child on a day-to-day basis. The concept of expressed emotion (EE) was first studied by G. W. Brown, E. M. Monck, G. M. Carstairs, and J. K. Wing (1962) as a method of predicting relapse in patients with schizophrenia and it has been found to be predictive of treatment outcomes in these populations (Butzlaff & Hooley, 1998; Leff & Vaughn, 1985). Since then, EE has been shown in multiple studies to be an aspect of the family environment that is associated with the persistence and course of a multiplicity of other psychiatric disorders in adults. Most research on juvenile populations using EE as a measure of family climate began in the early 1990's. Research findings report an association between EE and a whole range of psychiatric problems in children and adolescents. High rates of parental EE have been found in children with externalizing, internalizing, and overall behavior symptoms (Baker, Heller, & Henker, 2000; Frye & Garber, 2005; Peris & Hinshaw, 2003; Psychogiou, Daley, Thompson, & Sonuga-Barke, 2007). For example, high rates of EE have been found in parents of children with depression (Asarnow, Tompson, Woo, & Cantwell, 2001; Rogosch, Cicchetti, & Toth, 2004; Silk et al., 2009), anxiety disorders (Stern, 2003), ADHD (Daley, Sonuga-Barke, & Thompson, 2003), and self-injurious thoughts and behaviors (Wedig & Nock, 2007). Moreover, high levels of criticism have consistently been associated with disruptive behavior in children or conduct disorder (Baker et al., 2000; Caspi et al., 2004; Musser, Karalunas, Dieckmann, Peris, & Nigg, 2016; Denise Renee Nelson, 2001; Peris & Baker, 2000).

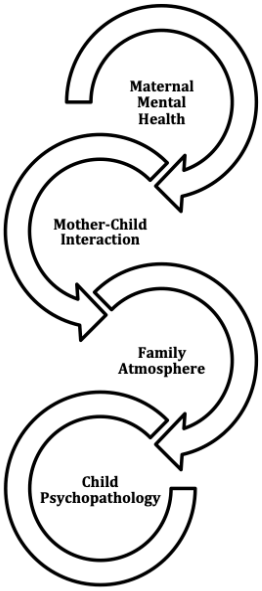

Figure 2: Environmental factors and child psychopathology

Because EE assessment is usually based on mothers' statements about the child, it is likely that mothers' own psychological functioning contributes to an understanding of their emotional attitudes toward their child in the way that mothers' own symptoms may influence their views about their child and their relationship with the child (Müller, Romer, & Achtergarde, 2014). This leads to the assumption that parental psychopathology might be part of the reason why parents express negative emotions towards their children (Achtergarde, Postert, Wessing, Romer, & Müller, 2015). Indeed, mothers with a history of depression, or currently diagnosed as

depressed or having symptoms of depression, have been found to express more negative attitudes about their children (Bolton et al., 2003; Frye & Garber, 2005; Green, Stanley, & Peters, 2007; Denise R Nelson, Hammen, Brennan, & Ullman, 2003; Rogosch et al., 2004; Tompson et al., 2010).

The documented associations between EE, maternal depression, and child psychopathology suggest that maternal EE may be involved in the underlying process by which maternal mental health problems can negatively impact child psychological development.

Gravener et al. (2012) found in their study that the link between maternal depression and children's externalizing and internalizing symptoms was mediated by maternal criticism. Denise R Nelson et al. (2003) also found that high critical EE partially mediated the association between maternal depressive symptoms and adolescent externalizing symptoms, but not internalizing symptoms. In a cross-sectional study of children aged 4 to 11, Bolton et al. (2003) found high critical EE to significantly mediate the association between maternal depressive symptoms and child externalizing behaviors.

In summary, this first chapter addresses the possible influence of various environmental factors (parental mental health status / patterns of caregiver-child interaction / family atmosphere) on children's maladjustment (see Figure 2).

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Pathways to children's maladjustment: The role of emotion regulation and physiological reactivity

How do caregiver-child interactional patterns affect children's emotion regulation?

As outlined, family stress, negative familial climate and dysfunctional patterns of interaction within a family represent one area of familial risk factors. Children growing up in a negative familial climate are often left alone with their emotions and are missing a parent who supports them in regulating strong feelings by reacting sensitively to their signals. When it comes to the regulation of children's emotional states, literature shows that children depend on co-regulation by their parents to learn how to adequately deal with their emotions (Ostlund, Measelle, Laurent, Conradt, & Ablow, 2017).

Emotion regulation is widely defined as the ability to correctly perceive, control and modify emotional states by modifying the situation itself that causes the emotional state through problem solving efforts, for instance, or by cognitive strategies such as the deployment of attention or cognitive reappraisal, and the ability to adjust emotion expression in a socially acceptable manner, even suppressing it if necessary (Gross & Thompson, 2007).

Rothbart and Bates (2006) labeled emotion regulation as effortful control and attributed it to temperamental factors in the child, comprising executive functioning skills and executive attention. Although they described their concept of effortful control as part of a child's temperamental constitution, they also argued that the child's familial environment has an important impact on effortful control skills in children. Particularly caregiver-child interactional patterns seem to play a crucial role. Indeed, many findings supported Rothbart and Bates's theory, finding less negativity and higher emotion regulating skills in children of mothers with high levels of sensitivity, responsiveness, warmth and positivity (Blair & Diamond, 2008; Gaertner, Spinrad, & Eisenberg, 2008; Li-Grining, 2007; Spinrad et al., 2007). Maternal structuring and limit setting behavior without being intrusive or authoritarian have also been found to have a positive effect on children's regulatory competencies (Hoffman, Crnic, & Baker, 2006; Lengua, Honorado, & Bush, 2007). On the other hand, harsh, intrusive and aggressive parenting styles have been found to affect children's self-regulatory skills adversely

(Xu, Farver, & Zhang, 2009). Furthermore, findings support the idea that, besides caregiver qualities such as sensitivity and structuring, the way caregivers react to children's emotional displays is also central when it comes to children's self-regulatory competencies. Lengua (2008), Yap, Allen, and Sheeber (2007) as well as Yap, Allen, and Ladouceur (2008) found that parents who react sensitively, supportively and in a validating way to children's emotional displays by helping them to cope with their emotions, have children with better self-regulatory skills, whereas aggressive, inflictive or harsh parental reactions more frequently accompanied lower self-regulatory skills in children (Spinrad et al., 2007; Valiente, Lemery-Chalfant, & Reiser, 2007). Another parental quality affecting self-regulatory competencies in children that has been identified in literature is parents' own emotional displays while interacting with their children and in this way serving as role models for their children in terms of emotional display (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Valiente et al. (2006) found a positive link between high maternal emotion expression and higher self-regulatory skills in children. Concerning this, it seems reasonable to assume that mental illness in mothers, such as depression, which commonly limits the frequency of emotional display by the affected person, might have an effect on the self-regulatory learning of the children living with a clinically depressed caregiver. Indeed, there is evidence that children of depressed mothers show impaired emotion regulation behaviors (Blandon, Calkins, Keane, & O'Brien, 2008; Feng et al., 2008). Another parental or family quality that is assumed to benefit children's emotion regulation is the extent to which emotions are openly discussed within the family (Thompson & Meyer, 2007).

Conduct disorder: An example of the association between emotion processing deficits and high psychosocial risk

A child's or adolescent's ability to cope with chronic stressful events or circumstances by accurately regulating their emotions seems to play an essential role in their vulnerability to the development of psychopathology (Compas et al., 2017; McRae & Mauss, 2016).

Emotion processing dysregulation, including emotion regulation capacities and emotional reactivity processes, as well as effortful control impairment have repeatedly been associated with the development of externalizing and internalizing behavior problems. Such studies used reported (self, relatives), behavioral, and/or

psychophysiological assessments of self-regulation, and linked genetic factors to the development of emotion dysregulation in children (Eisenberg, Spinrad, & Eggum, 2010).

Whereas findings concerning the associations between self-regulatory capacities (attentional and inhibitory control / effortful and reactive control) in externalizing disorders are quite robust and consistent throughout literature, findings regarding relationships between emotion regulation and internalizing behavioral problems seem to be less clear (Eisenberg et al., 2010).

In this thesis, we focus on the mechanisms underlying emotion processing in adolescents with externalizing disorders, specifically conduct disorder (see Figure 3), in a sample featuring various psychosocial risk factors including early trauma experiences, parental mental health, socioeconomic status and many others. There is substantial evidence that deficient emotion processing is a key factor in the development and maintenance of externalizing disorders such as attention deficit/hyperactivity disorder (ADHD) (Bunford, Evans, & Langberg, 2018; Shaw, Stringaris, Nigg, & Leibenluft, 2014), oppositional defiant behavior (ODD) or conduct disorder (CD) (Cavanagh, Quinn, Duncan, Graham, & Balbuena, 2017; Frick & Nigg, 2012) in children and adolescents.

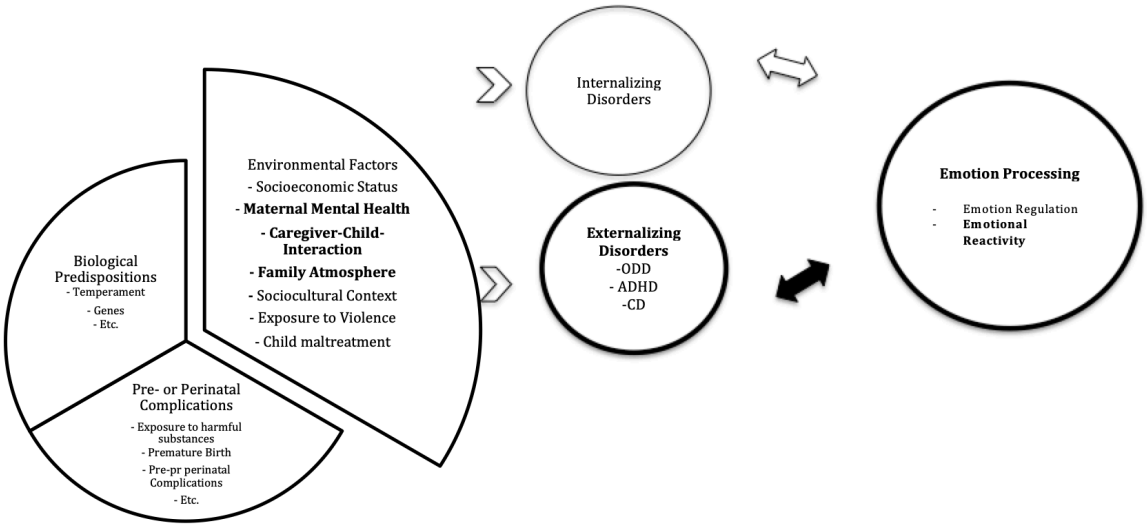

Figure 3. Emotion processing and adolescent's externalizing disorder.

While Cavanagh et al. (2017) found ODD to primarily comprise emotion dysregulation as one underlying factor covering emotional lability and irritability, the study results of Burke et al. (2010) yielded a more heterogenic perspective on ODD, suggesting ODD to be clustered by an affective component on the one hand and a behavioral component on the other hand. While the emotional component was found to be associated with more mood disorders such as depression, the behavioral component accounted for aggressive/dissocial tendencies predicting CD. Rowe et al. (2010) found similar results, labeling the emotional component in ODD *irritable* and the behavioral component *headstrong*.

Stringaris and Goodman (2009) proposed a three-factor model categorizing ODD as having an irritable dimension predicting later internalizing disorders such as depression and anxiety; a hurtful dimension strongly associated with callous-unemotional traits; and a headstrong dimension mostly found in ADHD.

Like ODD, CD has also been the subject of various research efforts in the past, trying to shed light on its heterogeneity through various concepts relating to differences in emotion regulation and reactivity.

Towards the heterogeneity of conduct disorder and its psychophysiological correlates in emotion processing

Conduct disorder (CD) in children and adolescents is described as a persistent kind of behavior that consistently violates the rights of others and in which the anticipated social and moral age-appropriate patterns of behavior are missing or not achieved (Moffitt & Scott, 2008). These children show repetitive and persistent antisocial behavior including aggression towards their environment, cruelty to people or animals, destruction of property, lying, truancy, stealing and running away from home (Association & Association, 2000). Young children with CD or psychological precursors of CD (e.g. oppositional, aggressive, impulsive behavior) are at high risk of engaging in delinquency or crime in adolescence, and of being convicted or arrested in adulthood (Moffitt et al., 2008; Moffitt & Scott, 2008). Moreover, CD is often related to poor socioeconomic status later in life, dropping out of school, and consecutive or comorbid mental health problems (e.g. depression, substance abuse) (Odgers et al., 2008). Hence, healthcare and societal costs are significant in CD patients, which is why it seems to be an important field of research.

There has been a large number of studies in the past 25 years which have included physiological measures in their theoretical considerations leading to an understanding of conduct disorder (CD) and its development and prevention. Particular attention is given to the mechanisms of the autonomic nervous system (ANS) with its inhibitory parasympathetic nervous system (PNS), and activating sympathetic nervous system processes in stress inducing situations. Heart rate (HR) is one of the most common biomarkers used to measure physiological correlates of emotion processing in CD, mainly because it can provide information on activity in both the parasympathetic nervous system (PNS) and the sympathetic nervous system (SNS), which are known to be essential in stress regulation. Low baseline heart rate reflects the autonomic activity without a stressor, and has been associated with CD (Portnoy & Farrington, 2015). Heart rate reactivity describes the change in heart rate from baseline to activity (Lorber, 2004) and thus provides information on how a stressor affects PNS and SNS. HR is not the only biomarker. Porges (1995) introduced the polyvagal theory, which deals with respiratory sinus arrhythmia (RSA), which is a vagally mediated modulation of HR occurring during the inhale/exhale cycle. RSA is known to cause heart rate variability (HRV), and both influence PNS activity. Graziano and Derefinko (2013) found low HRV to be associated with conduct problems. Beauchaine (2015) referred to RSA as a useful biomarker in emotion regulation. Thayer and Lane (2009) interpreted HRV as an index of inhibitory control on the amygdala labeled medial Prefrontal Cortex (mPFC) and thus associated its functioning with emotion regulation (Thayer, Åhs, Fredrikson, Sollers III, & Wager, 2012). Moreover, Beauchaine (2012) found the cardiac pre-ejection period (PEP) to be another valuable biomarker, mainly in regard to impaired reward sensitivity in CD children and adolescents, reflecting SNS activity.

Despite these results focusing on the association between conduct problems and low ANS activity, findings are quite inconsistent. Some studies found either no differences in ANS activity, or even higher ANS activity levels in CD children. Two theoretical perspectives, at first sight quite contradictory, shed light on how complex the issue of conduct disorder symptoms differentiation is. One of these concepts argues that CD can be explained by a general physiological over-arousal and that this over-arousal is due to a high level of fearfulness or anxiety. This leads to the assumption that these children are more sensitive to stressful events and therefore tend to exhibit aggressive, antisocial behavior in stress evoking situations. There is substantial evidence

supporting this theoretical concept, finding higher ANS activity in CD children and adolescents (Scarpa, Haden, & Tanaka, 2010; Schoorl, Van Rijn, De Wied, Van Goozen, & Swaab, 2016). In contrast, Beauchaine (2012) found significant physiological under-arousal in CD adolescents and postulated that these children constantly seek stimulation to raise their arousal to a normal level. This could explain why CD children and adolescents tend to engage in dangerous activities, seeking thrills. There are a number of study results supporting this perspective, finding low baseline HR and low HR reactivity in CD patients (Beauchaine, 2012; Sijtsema et al., 2010). Moreover, Beauchaine et al. (2013) found less SNS activity (e.g. lengthened resting pre-ejection periods) in children with conduct problems.

These inconsistencies highlight the need to attach further importance to the heterogeneity of conduct disorder while noting its importance in psychophysiological assessments.

One impeding factor is the heterogeneity of the onset, course and occurrence of CD. In literature, four subtypes are described. The first approach considers CD onset as the most important factor in forecasting the course and severity of CD. It distinguishes between the child-onset (i.e., at least one CD symptom prior to age 10) and the adolescent-onset (i.e., no CD symptom prior to age 10). The concept behind this theoretical perspective is that childhood-onset CD is more severe and more strongly related to neurocognitive impairment and deficits in emotional regulation than adolescent-onset CD is (Moffitt & Scott, 2008). Adolescent-onset CD is seen as a normative process in development in youth (e.g. adolescent rebellion). Accordingly, one would expect that biomarkers of emotional regulation and measures of neurocognitive functioning in the child-onset group would differ significantly from those in the adolescent-onset group. However, study results are inconsistent, as they suggest similar emotional processing and emotional learning in both groups. Moreover, evidence is still limited and research gaps are prominent. Only a few studies compared both groups directly using biomarkers. Moreover, important biomarkers have often not been incorporated in study designs. Nevertheless, recent study findings again argued against this proposed neurobiological etiological distinction. Moffitt and Scott (2008) argue that the courses of CD are too heterogenic to draw conclusions from CD onset, arguing that some children with childhood-onset do desist in CD, while some adolescent-onset CD children do not desist in antisocial behavior. Moreover, findings from Fairchild et al. (2010) lead to the assumption that there are

relevant sex differences, in that female adolescent-onset CD resembles male childhood-onset CD in regard to neuropsychological functioning deficits.

Moreover, there is evidence suggesting the potential influence of collateral comorbid disorders on CD, reflecting diversity in ANS activity as well as gender effects on ANS activity.

One approach to untangle the heterogeneity problem in CD is to discriminate between CD only and CD in combination with externalizing and internalizing comorbid disorders. In terms of externalizing comorbid disorders, one approach discriminates between CD only or ADHD only on the one hand, and CD in combination with ADHD on the other hand, suggesting that children with CD and comorbid ADHD show neuropsychological impairment similar to the deficits shown by CD only patients. If this conceptualization is true, one should expect the CD+ADHD group to be characterized by a low-arousal level and a high level of fearlessness. Study results sustain this suggestion, showing that ADHD on its own is usually linked to hyper arousal, but when it is in combination with antisocial behavior, children show autonomic under arousal, suggesting that both groups (CD and CD +ADHD) are rather homogeneous in terms of physiology (Beauchaine, Katkin, Strassberg, & Snarr, 2001; Northover, Thapar, Langley, & Van Goozen, 2015). Because of varying study designs and the varying biomarkers used, there have also been contradictory findings (Van Lang et al., 2007), so more studies are needed to underpin the use of this subtyping method.

Like the situation in regard to ADHD, the co-occurrence of internalizing problems and antisocial behavior is quite common in clinical practice. Studies focusing on this subgroup brought up relatively consistent findings, indicating that this subgroup is characterized by physiological hyper arousal, suggesting that the aggressive behavior of these children and adolescents has its seed in fearfulness, not fearlessness (Dierckx et al., 2014; Pang & Beauchaine, 2013; Schoorl et al., 2016).

Another perspective that has been given much attention to in recent research focuses on the presence or absence of callous-unemotional (CU) traits, also labeled under the umbrella term of low prosocial emotions specifier (LPE; American Psychiatric Association, 2013), in children and adolescents diagnosed with CD. There is a large amount of evidence suggesting that, compared to youth without CU traits, those high in CU traits show

more fearlessness, more insensitivity to punishment and a considerably lower amount of anxiety (Frick, 2012), e.g. physiological under arousal (de Wied, van Boxtel, Matthys, & Meeus, 2012; Mills-Koonce et al., 2015) and low autonomic activity (Anastassiou-Hadjicharalambous & Warden, 2008; Kimonis et al., 2008; Musser, Galloway-Long, Frick, & Nigg, 2013). Such young people resemble youths scoring high on psychopathic traits.

In contrast, findings suggest that children with antisocial behavior but without CU traits show higher levels of fear and anxiety (Fanti, Panayiotou, Lazarou, Michael, & Georgiou, 2016; Frick & Viding, 2009), e.g. physiological over arousal similar to that of the CD+Internalizing group. Hence discrimination between CD only and CD with co-occurring CU traits could explain the heterogeneity in CD and enable the identification of distinct subtypes of CD, including distinct physiological markers.

A last concept on subtyping CD in literature is a discrimination focusing on aggression types characterizing CD. Here, one discriminates between proactive and reactive aggression. Whereas proactive aggression is characterized by controlled, planned and purposeful aggression with the aim of achieving a goal, reactive aggression is defined as an uncontrolled aggressive act resulting from a real or perceived provocation. Moreover, proactive aggression was often found to be linked to fearlessness and a low reaction to aversive stimuli, whereas reactive aggression was found to be linked to neuroticism, anxiety and higher arousal levels (Scarpa et al., 2010). Out of this evidence comes the assumption that proactive aggression would be similar to the CD+CU hypo arousal subtype scoring high on psychopathic traits and reactive aggression would be linked to the CD only type, characterized by hyper-arousal scoring high on anxiety. Reviewing study results concerning this subtyping method and their link to autonomic arousal, Fanti (2018) found that up to now findings have been too inconsistent to derive conclusions. Therefore, the CU subtyping method seems to better inform CD heterogeneity.

In terms of sex differences, recent research results suggest that a higher resting heart rate in girls should be taken into consideration as an explanation for the largely documented gender gap when it comes to the quantity and occurrence of antisocial behavior in our society (Choy, Raine, Venables, & Farrington, 2017; Portnoy & Farrington, 2015). It is well known and documented, that in terms of their biological disposition, boys and girls differ concerning their resting heart rate, with girls presenting on average higher resting heart rates (Koenig &

Thayer, 2016; Ostchega, Porter, Hughes, Dillon, & Nwankwo, 2011). It is assumed that girls or women are not as often involved in antisocial behavior because of their higher heart rates in contrast to the lower resting rates throughout development in boys. This assumption has been strengthened by recent research findings associating lower overall resting heart rates in both male and female antisocial behavior (Portnoy & Farrington, 2015).

Finally, it is important to notice that when associating CD with differences in ANS activity in boys and girls separately, as well as differentiated by collateral comorbidity as described above, potential confounding factors on ANS activity should be taken into account. It is well documented that factors such as smoking, caffeine use, BMI, drugs, amount of exercise, and cognitive ability can influence ANS activity and should be considered when evaluating ANS activity in relation to CD (Alvares, Quintana, Hickie, & Guastella, 2016; Green et al., 2007; Hu, Lamers, de Geus, & Penninx, 2017; Piotrowska, Stride, Croft, & Rowe, 2015). Furthermore, environmental risk factors (e.g. socioeconomic status, parental mental health, parent-child interaction, exposure to violence, maltreatment experiences, etc.) should also be accounted for when evaluating potential pathways and explanations for the development, maintenance or aggravation of deficient emotion processing and conduct disorder in youth.

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Aims of the Thesis and Gaps in the Literature

The main aim of this thesis was to investigate the influence of maternal mental health and mother-child interactional patterns on children's mental health and neurobiological stress regulation.

In a first step, we examined associations between maternal self-reported psychopathology, mother-child interaction and behavioral, emotional, and social functioning in their children (Chapter 2). Using research findings, we hypothesized a positive link between maternal mental strain and child psychopathology. Furthermore, we expected to find more behavioral, emotional and social problems in children in the context of negative maternal interaction quality.

In a second step, we further aimed to highlight the links between maternal expressed criticism, mother-child interaction and maternal mental problems on behavior problems in children (Chapter 3). We hypothesized higher rates of psychopathology in children with mothers expressing more criticism towards their children. In addition, we expected to find positive links between maternal criticism and maternal mental strain as well as a negative association between maternal criticism and a mother's interactional qualities such as sensitivity and structuring behavior. To evaluate maternal criticism, the concept of expressed emotion (EE) was used. In literature, high parental EE is known as a potential risk factor in the development of psychopathology in children, but little is known about how EE affects mother-child interaction. Moreover, EE has often been linked to depression in mothers in research findings, whereas the link between EE and other domains of maternal psychological strain have been neglected.

In a third step, we aimed to investigate how maternal factors such as maternal criticism and mother-child-interactional patterns affect the neurobiological stress regulation system of children. For this purpose, we included stress regulation markers such as heart rate and heart rate variability during a stress-inducing task, as well as measures of hair cortisol as a long-term stress marker. Unfortunately, because of a large amount of missing data and a small sample size, the latter aim could not be investigated in a satisfying way, as results did not generate enough data to derive an original paper worthy of publication. Since the mechanisms of stress regulation and reactivity in neurobiological processes was a major focus in the present thesis, these mechanisms were studied in another project evaluating the autonomic nervous system (ANS) functioning during an emotion

evoking task as a biological indicator of emotion regulation in adolescent boys and girls diagnosed with conduct disorder compared to a nonclinical sample (Chapter 4). Overall, as described earlier, there is substantial evidence, that a girl's ANS response to stress differs from a boy's ANS response. However, most studies evaluating psychophysiological measures of ANS responses in CD patients only included male subjects, so that the generalizability of these findings to females should be called into question. Therefore, we aimed to investigate both girls and boys with CD to increase the knowledge of CD in girls as well as to alleviate the lack of studies on sex differences in CD. Furthermore, most studies used community samples to investigate ANS responses to stress inducing tasks in relation to aggressive behavior tendencies in youth. Studies investigating clinical samples are limited; hence, the association between ANS and antisocial behavior in its clinical presentation (Beauchaine et al.) remains ambiguous. In addition, recent findings emphasized the need to take into account the heterogeneity of CD when evaluating its psychophysiological manifestations. In this regard, CD subtypes, particularly CD in conjunction with internalizing and/or LPE comorbidity should be taken into consideration. Based on what we found in literature, we hypothesized an increased ANS response to the emotion evocation task (i.e. higher heart rate response, as well as higher PNS and SNS response) in boys and girls with CD as compared to typically developing children and adolescents. We expect this to be more pronounced in girls since CD girls present with higher rates of internalizing comorbidity. Consequently, we expected the CD subgroup with a comorbid internalizing disorder to show the highest ANS response, and the CD subgroup with LPE to show the lowest ANS response.

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Chapter 2 Verhaltens- und Emotionale Probleme bei Vorschulkindern im Kontext der Mutter-Kind-Interaktion – zum Einfluss der mütterlichen psychischen Gesundheit

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Zusammenfassung

Frühe Interaktionserfahrungen zwischen Eltern und ihren Kindern wirken sich langfristig auf deren psychische Entwicklung aus. Jedoch können verschiedenen psychosoziale Risikofaktoren, insbesondere mütterliche psychische Erkrankungen, die Qualität solcher Interaktionen verändern und sich damit ungünstig auf die psychische Gesundheit von Kindern auswirken. In der vorliegenden Untersuchung wurde deshalb geprüft, ob sich psychische Probleme von Müttern auf ihr Interaktionsverhalten auswirken und ob dieses wiederum mit Verhaltensproblemen bei Vorschulkindern assoziiert ist. Es wurden insgesamt 63 Mutter-Kind-Paare untersucht. Die psychische Gesundheit der Mütter wurde mit Hilfe des Brief Symptom Inventory (BSI), Verhaltensprobleme der Kinder mittels der CBCL erfasst. Die Mutter-Kind-Interaktion wurde während einer standardisierten Verhaltensbeobachtung videographiert und von zwei blinden Ratern ausgewertet.

Multiple Regressionsanalysen zeigen, dass die globale psychische Belastung von Müttern 13% der Varianz externalisierender und 14.5% der Varianz internalisierender Symptome bei Vorschulkindern aufklärt. Weiterhin wurde deutlich, dass nur bei den internalisierenden Störungen die Qualität der Mutter-Kind-Interaktion einen Effekt auf die Ausprägung kindlicher Symptome hatte. Außerdem fanden wir einen Mediatoreffekt für mütterliche Intrusivität.

Die Befunde der vorliegenden Studie ermöglichen somit ein besseres Verständnis der Entstehung von Verhaltensauffälligkeiten im Vorschulalter, da sie spezifische Interaktionsmerkmale als Risikofaktoren für internalisierende Probleme identifizieren konnten und die Bedeutung der psychischen Gesundheit der Mutter unterstreichen. Daraus kann abgeleitet werden, dass bei einer psychotherapeutischen Behandlung von Vorschulkindern, neben der symptomorientierten Therapie, eine Entlastung der Mütter und eine Verbesserung der Mutter-Kind-Interaktion von großer Relevanz ist.

Schlüsselwörter: Psychische Symptome, Verhaltensprobleme, Depression, Angst, Mutter-Kind-Interaktion, Feinfühligkeit.

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Abstract

Child healthy development is largely influenced by parent–child interactions. However, the parent–child relationship can be affected by several psychosocial risk factors, especially maternal mental health, that undermine its quality and in turn play a negative role in children's psychological health. The present study therefore examined associations between maternal self-reported psychopathology and behavioral, emotional, or social functioning in preschool children, and which mechanisms could explain this association. We assessed 63 mother-child-dyads. Maternal symptoms of psychopathology were assessed by the Brief Symptom Inventory (BSI), children's behavioral problems by the CBCL. The quality of mother–child interactions was observed during a standardized problem-solving task. Interactions were videotaped and rated by two blind raters.

Multiple regression analyses show, that maternal mental strain accounted for 13% of the variance of children's externalizing and 14.5% of internalizing symptoms. Furthermore, the quality of mother-child-interactions predicted also internalizing problems in preschool children. Additionally, results suggest a mediating role of maternal intrusiveness on the association between maternal mental health problems and internalizing but not externalizing symptoms. Children of mothers reporting high levels of mental strain had less internalizing problems if their mother presented less intrusiveness during the interaction. Consequently, this study adds new insights and understanding of behavioral problems of preschoolers. In order to improve the treatment of preschool children with mental health problems, it is mandatory to reduce maternal psychological strain and to improve the quality of mother-child-interactions.

Key words: maternal psychological strain, behavioral problems, depression, anxiety, mother-child-interaction, sensitivity

Einleitung

Eine Vielzahl von Studien konnte zeigen, dass Kinder psychisch kranker Eltern ein erhöhtes Risiko haben, später selbst psychisch auffällig zu werden (z. B. Bornovalova, Hicks, Iacono, & McGue, 2010; Harold et al., 2011; Micco et al., 2009; Piche, Bergeron, Cyr, & Berthiaume, 2011).

So zeigten beispielsweise Breaux, Harvey und Lugo-Candelas (2014), dass 3-Jährige, deren Mütter vermehrt psychische Symptome berichteten, im Alter von 6 Jahren häufiger unter internalisierenden und externalisierenden Problemen litten und geringere soziale Kompetenzen hatten. Jedoch war dieser Zusammenhang nur für Aufmerksamkeitsdefizit-/Hyperaktivitätsstörungen störungsspezifisch. Bei allen anderen psychischen Auffälligkeiten der Mütter war der Zusammenhang eher genereller Natur dahingehend, dass ihre Kinder vermehrt Verhaltensauffälligkeiten entwickelten, aber nicht zwangsläufig die gleiche Störung wie die Mutter. Dies unterstreicht, dass neben Vererbungsprozessen, vor allem interaktionelle Einflüsse bei der transgenerationalen Weitergabe psychischer Störungen eine Rolle spielen. Interaktionen mit der Hauptbezugsperson sind die ersten und wichtigsten sozialen Erfahrungen eines Kindes. Diese ersten sozioemotionalen Erlebnisse fallen in die Phase des stärksten Hirnwachstums und entsprechend prägen sie die biologische Struktur des sich entwickelnden Gehirns nachhaltig (Sullivan, 2012). Somit können sich frühe Interaktionserfahrungen langfristig auf die Regulation emotionaler Zustände eines Kindes auswirken (Spangler, 2011). Frühe Störungen emotionaler Fertigkeiten können wiederum weitere Verhaltensauffälligkeiten und Schwierigkeiten nach sich ziehen. So konnte beispielsweise gezeigt werden, dass psychische Auffälligkeiten von Eltern, vor allem mütterliche Depressionen, häufiger mit externalisierenden Verhaltensstörungen der Kinder einhergingen (Villodas, Bagner, & Thompson, 2015). Dabei moderierte aggressives Interaktionsverhalten der Mutter den Zusammenhang zwischen mütterlichen Depressionen und externalisierenden Verhaltensproblemen des Kindes. Zu ähnlichen Ergebnissen kommen auch Bao et al. (2016). Die Autoren berichten, dass neben kindlichen Temperamentsmerkmalen vor allem mütterliche Depressionen und ungünstige elterliche Erziehungsstrategien zu einer Erhöhung von Verhaltensauffälligkeiten bei Vorschulkindern führten. Auch in einer Studie von Choe, Olson und Sameroff (2013) erhöhte emotionaler Stress von Müttern das Risiko für externalisierende Störungen vor allem durch suboptimales

Erziehungsverhalten (z.B. wenig grenzsetzendes Verhalten und geringe mütterliche Wärme) und damit wenig Förderung der kindlichen Selbstregulation. Entsprechend ist davon auszugehen, dass sich eine psychische Erkrankung der Mutter negativ auf die Entwicklung der Emotionsregulation auswirken kann und damit eine wichtige Rolle bei der Entstehung von Psychopathologien spielt (Barnow, 2012; Kullik & Petermann, 2012).

In Hinblick auf internalisierende Probleme fanden Zalewski, Thompson und Lengua (2015), dass mütterliche Zurückweisung des Kindes den Zusammenhang zwischen Depressivität und internalisierenden Symptomen (Ängste, Depressionen) in der Präadoleszenz moderierte. In einer eigenen Studie konnten wir zeigen, dass der mütterliche emotionale Ausdruck einen deutlichen Effekt auf das kindliche Verhalten in einer neuen Situation hat. Wenn Mütter in eine negative Stimmung versetzt wurden und damit negative emotionale Hinweisreize an ihr Kind sendeten bzw. ihr Kind weniger ermutigten, verhielten sich die Kinder in einer neuen und für sie noch unbekannten Situationen ängstlicher (Bolten & Schneider, 2010, 2011).

Zusammenfassend lässt sich festhalten, dass psychische Erkrankungen von Eltern ein bedeutender Risikofaktor für das Auftreten psychischer Erkrankungen bei Kindern ist. Weiterhin können Defizite in der Emotionsregulation als Ursache für die Entstehung emotionaler und behavioraler Schwierigkeiten im Kindesalter ausgemacht werden. Da sich die Emotionsregulation in interaktionellen Kontexten entwickelt, stellen wir die Hypothese auf, dass Mütter mit psychischen Symptomen ein ungünstiges Interaktionsverhalten (geringere Feinfühligkeit; Strukturierung, Harmonie und Bezogenheit, sowie mehr Intrusivität) zeigen und dass diese dysfunktionalen Interaktionsmerkmale zu emotionalen und Verhaltensschwierigkeiten bei Vorschulkindern führen.

Methoden

Studienprotokoll und Teilnehmer

Das Studienprotokoll wurde durch die Ethikkommission Beider Basel (EKBB) genehmigt und entspricht der Deklaration von Helsinki von 1975. Alle Teilnehmer wurden entweder durch psychotherapeutische Mitarbeiter der Kinder- und Jugendpsychiatrischen Klinik Basel oder über Anzeigen auf der Homepage der Universität Basel rekrutiert. Mutter-Kind-Dyaden wurden in die Studie eingeschlossen, wenn das Kind zwischen 5 und 7

Jahre alt war, keine Tiefgreifenden Entwicklungsstörungen hatte und die Mutter über ausreichend Deutschkenntnisse verfügte, so dass sie die Fragebögen beantworten konnte.

Nachdem die Eltern schriftlich ihr Einverständnis zur Teilnahme an der Studie erteilt hatten, wurde mit den Mutter-Kind-Dyaden eine standardisierte Verhaltensbeobachtung durchgeführt. Im Anschluss füllten die Mütter die Fragebögen (CBCL, BSI) aus.

Für die vorliegende Publikation konnten die Daten von insgesamt 63 Mutter-Kind-Paaren ausgewertet werden. Dabei waren 31 Kinder Patienten einer Kinder- und Jugendpsychiatrischen Klinik und 32 Kinder waren Kinder ohne psychische Auffälligkeiten (Selbstbericht der Mütter). 29% der Stichprobe (N = 18) wiesen mit einem T-Wert von über 70 in der CBCL-Gesamtskala einen klinisch auffälligen Wert auf. Das mittlere Alter der Kinder lag bei 6.21 Jahren (SD = 0.8), 64 % waren Jungen und hatten primär die Schweizer oder eine EU Nationalität (75%). Das mittlere Alter der Mütter war 37.5 (SD = 5.6) Jahre, 67% von ihnen waren verheiratet oder lebten in einer festen Partnerschaft und 85% hatten eine schulische Ausbildung von 10 oder mehr Jahren.

Messinstrumente

Mutter-Kind-Interaktion

Die Mutter-Kind-Interaktion wurde während einer standardisierten Problemlöseaufgabe mit zwei digitalen Videokameras aufgezeichnet. In Anlehnung an das Studiendesign von Schneider et al. (2009) wurde als Beobachtungssituation das gemeinsame Abzeichnen eines Hauses mit Hilfe der so genannten “Etch-A-Sketch Zaubertafel“ gewählt. Bei der Zaubertafel handelt es sich um ein Spielzeug mit zwei Knöpfen, welches das Zeichnen von vertikalen und horizontalen Linien ermöglicht. Durch das gleichzeitige Betätigen beider Knöpfe lassen sich kreisförmige und diagonale Linien zeichnen. Jede Mutter-Kind-Dyade wurde gebeten, durch das Drehen der zwei Knöpfe gemeinsam ein Haus nach einer Vorlage abzuzeichnen. Dabei durften Mutter und Kind jeweils nur einen der zwei Knöpfe bedienen, so dass beide Interaktionspartner miteinander kooperieren mussten, um diese Aufgabe zu bewältigen. Der Versuchsleiter instruierte jedes Mutter-Kind-Paar und verließ danach jeweils den Raum. Alle Interaktionen wurden aufgezeichnet, um sie anschließend auswerten zu können. Jede Dyade erhielt max. 5 Minuten zum Lösen der Aufgabe. Falls eine Zeichnung innerhalb dieser Zeitfrist nicht beendet wurde, unterbrach der Versuchsleiter jeweils die Interaktion.

Alle Videos wurden durch zwei unabhängige Rater, die keine Informationen zur Mutter oder zum Kind hatten, mit der Software „Interact“ (Mangold Software & Consulting) ausgewertet. Dabei wurde ein von der Erstautorin entwickeltes Ratingmanual basierend auf der Bindungstheorie (Ainsworth, 1979; Bowlby, 1969) und den Emotional Availability (EA) Scales von Biringen, Robinson und Emde (2000) verwendet. Im Manual werden vor allem konkrete, quantitative Verhaltensweisen der Mutter berücksichtigt. Es wird davon ausgegangen, dass alle Interaktionen bidirektional sind. Das bedeutet, dass sowohl Merkmale mütterlichen als auch kindlichen Verhaltens in die Bewertung mit einbezogen werden, da beide Interaktionspartner einen Einfluss auf die Beziehungsgestaltung haben. Wie in Tabelle 1 dargestellt, wurden alle Mutter-Kind-Dyaden hinsichtlich fünf verschiedener Interaktionsmerkmale beurteilt. Dabei handelt es sich bei den ersten drei Dimensionen um Skalen, welche das Verhalten der Mütter beurteilen, während die letzten zwei Skalen die Interaktion als Ganzes einschätzen.

Tabelle 1

Auswertungsschema und Interraterreliabilität der Mutter-Kind-Interaktion

Skala	Beschreibung	Abstufungen	Kappa
Feinfühligkeit	Fähigkeit der Mutter kindliche Emotionen akkurat wahrzunehmen und zu interpretieren, um dann adäquat darauf zu reagieren	1 = geringe Sensitivität 5 = hohe Sensitivität	.57
Strukturierung	Fähigkeit der Mutter die Interaktion mit Ihrem Kind entsprechend seinem Alter und seinen Bedürfnissen zu strukturieren	1 = keinerlei Strukturierung bzw. Überstrukturierung 5 = angemessene Strukturierung	.64
Intrusivität	Ausmaß, in dem das Verhalten der Mutter mit dem kindlichen Autonomiebedürfnis kollidiert	1 = keine Intrusivität 5 = viel Intrusivität	.69
Harmonie	Anzahl der Konflikte in der Interaktion	1 = viele Konflikte 5 = keine Konflikte	.72
Bezogenheit	Spiegelt wider, wie gut das Kind auf die Beziehungs- und Strukturierungsangebote der Mutter eingeht	1 = geringe Reaktion des Kindes auf Interaktionsangebote 5 = starke Reaktion des Kindes auf Interaktionsangebote	.59

Wie aus Tabelle 1 ersichtlich, lagen die Kappa-Koeffizienten zwischen .57 und .72 und sind damit in einem mittleren bis guten Bereich einzuordnen. Alle Videos wurden in 30 Sekunden-Intervalle sequenziert. Die Dimensionen wurden durch die Rater jeweils getrennt beurteilt, so dass für jedes Intervall jeweils nur eine Einschätzung (Wert zwischen 1 und 5) für die jeweilige Dimension (Feinfühligkeit, Strukturierung etc.) abgegeben wurde. Für die Auswertung der Daten wurde jeweils der Mittelwert aus den Werten beider Rater gebildet.

Verhaltens- und emotionale Probleme der Vorschulkinder

Verhaltens- und emotionale Probleme der Kinder wurden mit Hilfe der Elternversion der *Child Behavior Checklist (CBCL; Achenbach, 1998)*, einem Fragebogen mit insgesamt 113 Items, erfasst. Die CBCL erlaubt die symptomorientrierte Diagnostik von Verhaltensauffälligkeiten, emotionalen und somatischen Schwierigkeiten. Der Fragebogen enthält acht beurteilungsübergreifende Syndromskalen (Sozialer Rückzug, Körperliche Beschwerden, Angst/Depressivität, Soziale Probleme, Schizoid/Zwanghaft, Aufmerksamkeitsstörung, Dissoziales Verhalten, Aggressives Verhalten). Aus den Syndromskalen wurden die Skalen zu internalisierenden und externalisierenden Symptomen ($CBCL_{ext}$/$CBCL_{int}$) des Kindes gebildet. Die internen Konsistenzen der einzelnen Subskalen sind als gering einzustufen, jedoch weißt der Gesamtauffälligkeitswert gute bis sehr gute interne Konsistenzen auf (α = .82 - .93). Die Validität der CBCL wurde in mehrere Studien nachgewiesen. So konnte die CBCL beispielsweise hochsignifikant zwischen Kindern mit Angststörungen, Aufmerksamkeitsstörungen, beiden Störungen oder keiner Störung unterscheiden (Schmeck et al., 2001).

Verhaltens- und emotionale Probleme der Mütter

Um die psychischen Symptome der Mütter zu untersuchen, wurde die deutsche Fassung des *Brief Symptoms Inventar (BSI; Franke et al., 2011)* verwendet. Das BSI ist die Kurzform der SCL-R-90 (Derogatis, Lipman, & Covi, 1973), und enthält 53 Items, welche 9 Symptomskalen zugeordnet werden können: Somatisierung, Zwanghaftigkeit, Unsicherheit im Sozialkontakt, Depressivität, Ängstlichkeit, Aggressivität/Feindseligkeit, Phobische Angst, Paranoides Denken und Psychotizismus. Außerdem kann ein Global Severity Index (GSI) berechnet werden, welcher die psychische Belastung der Mütter erfasst. Die interne Konsistenz der Skalen lag

in einer Normstichprobe (Bevölkerungsstichprobe) zwischen $\alpha = .39$ und $\alpha = .72$, für den GSI zwischen $\alpha = .92$ und $\alpha = .96$. Die Ergebnisse der Validitätsprüfung lassen ebenfalls auf eine gute bis sehr gute Validität schließen.

Datenauswertung

Die Daten wurden mit Hilfe des Statistikprogramms SPSS für Windows, Version 24 (SPSS Inc., Chicago, Illinois) ausgewertet. In einem ersten Schritt wurde mittels T-Tests für unabhängige Stichproben geprüft, ob sich Mütter mit psychischen Symptomen in ihrem Interaktionsverhalten von Müttern ohne psychische Symptome unterscheiden bzw. ob sie häufiger Kinder mit Verhaltens- und emotionalen Problemen haben.

Zur Überprüfung der Hypothese hinsichtlich eines moderierenden Effektes der Mutter-Kind-Interaktion, wurden für jede der zwei Abhängigen Variablen (Externalisierende Auffälligkeiten, Internalisierende Auffälligkeiten gemessen mit der CBCL) jeweils fünf hierarchische Stepwise Regressionsanalysen mit der Funktion ENTER durchgeführt, da für jede Mutter-Kind-Dyade insgesamt fünf verschiedene Merkmale der Interaktion gemessen wurden. Dabei wurde zuerst der einfache Einfluss mütterlicher psychischer Symptome (GSI) auf die kindlichen Verhaltensprobleme (CBCLext / CBCLint) untersucht. In einem zweiten Schritt wurde geprüft, inwiefern Merkmale der Mutter-Kind-Interaktion (Feinfühligkeit, Strukturierung, Intrusivität, Harmonie und Bezogenheit) Verhaltensprobleme des Kindes vorhersagen können. In einem dritten Schritt wurde schließlich der kombinierte Einfluss von psychischen Symptomen der Mutter und ihrem Interaktionsverhalten auf externalisierende bzw. internalisierende Störungen des Kindes untersucht. Um diese Mediatoreffekte zu prüfen, wurden Interaktionsterme gebildet, indem der Prädiktor (GSI) jeweils mit dem Mediator multipliziert wurde. Da eine solche Multiplikation jedoch zu einer linearen Abhängigkeit zwischen den Variablen und dem Produkt dieser Variablen führen kann und damit zum Problem der Multikolinearität, empfehlen verschiedene Autoren (Aiken & West, 1991; Ledermann & Bodenmann, 2006) sowohl die Prädiktoren als auch die Mediatoren vor der Produktbildung zu zentrieren, indem der jeweilige Mittelwert der entsprechenden Variablen vom Individualwert der Personen subtrahiert wird. Von einem Mediator kann gemäß Kenny, Kashy und Bolger (1998) dann gesprochen werden, wenn die Regressionskoeffizienten der direkten Verbindungen zwischen Prädiktor und Kriterium signifikant schwächer ausfallen, nachdem die

Mediatorvariable in die Analyse einbezogen wurde. Um die Größe und die Richtung des Interaktionseffektes interpretieren zu können, empfehlen Aiken and West (1991) die grafische Darstellung der Regressionslinien.

Ergebnisse

Mütterliche psychische Symptome und kindliche Verhaltensprobleme

Eine explorative Datenanalyse ergab, dass keine der eingeschlossenen Mütter einen GSI Wert über dem Klinischen Cut-off aufwies. Um trotzdem die Hypothese prüfen zu können, dass Mütter mit mehr psychopathologischen Symptomen häufiger Kinder mit Verhaltens- und emotionalen Problemen haben, wurde eine Gruppenvariable „Angst/Depression" gebildet, da es bei den zwei Subskalen „Depressivität" und „Ängstlichkeit" insgesamt 15 Mütter mit erhöhten Werten gab, welche entweder auf einer (Ängstlichkeit: n = 5 oder Depressivität: n = 3) oder auf beiden (n = 7) Skalen Werte über dem Cut-off aufwiesen. Mütter, welche auf den Symptomskalen Depressivität oder Ängstlichkeit keine auffälligen Werte aufwiesen, wurden der Kontrollgruppe zugeordnet. Mit diesen Gruppen wurden T-Tests für unabhängige Stichproben gerechnet. Als abhängige Variable wurden alle CBCL Subskalen einschließlich der Skalen Externalisierende und Internalisierende Störungen festgelegt.

Wie in Abbildung 1 zu erkennen ist, unterscheiden sich die Kinder, deren Mütter erhöhte Angst und/oder Depressionswerte im BSI berichten in fast allen Subskalen der CBCL signifikant von den Kindern der Mütter ohne erhöhte Angst/Depressions-Symptome. Lediglich auf den Skalen „körperliche Beschwerden" *(t = 1.87, df = 7.5, p = .10)* und „Aufmerksamkeitsprobleme *(t = 1.82, df = 61, p = .073)* gab es nur einen Trend. Die Differenzen der T-Werte zwischen den Gruppen lagen zwischen 5.97 (Aufmerksamkeitsprobleme, *Cohens d = 0.82*) und 12.68 (ängstlich-depressiv; *Cohens d = 1.82*) bzw. bei 10.57 (Externalisierende Störungen; *Cohens d = 1.15*) und 13.76 (Internalisierende Störungen; *Cohens d = 1.47*) T-Wert Punkten, wobei die Kinder der Mütter ohne ängstlich-depressive Symptome jeweils niedrigere T-Werte aufwiesen.

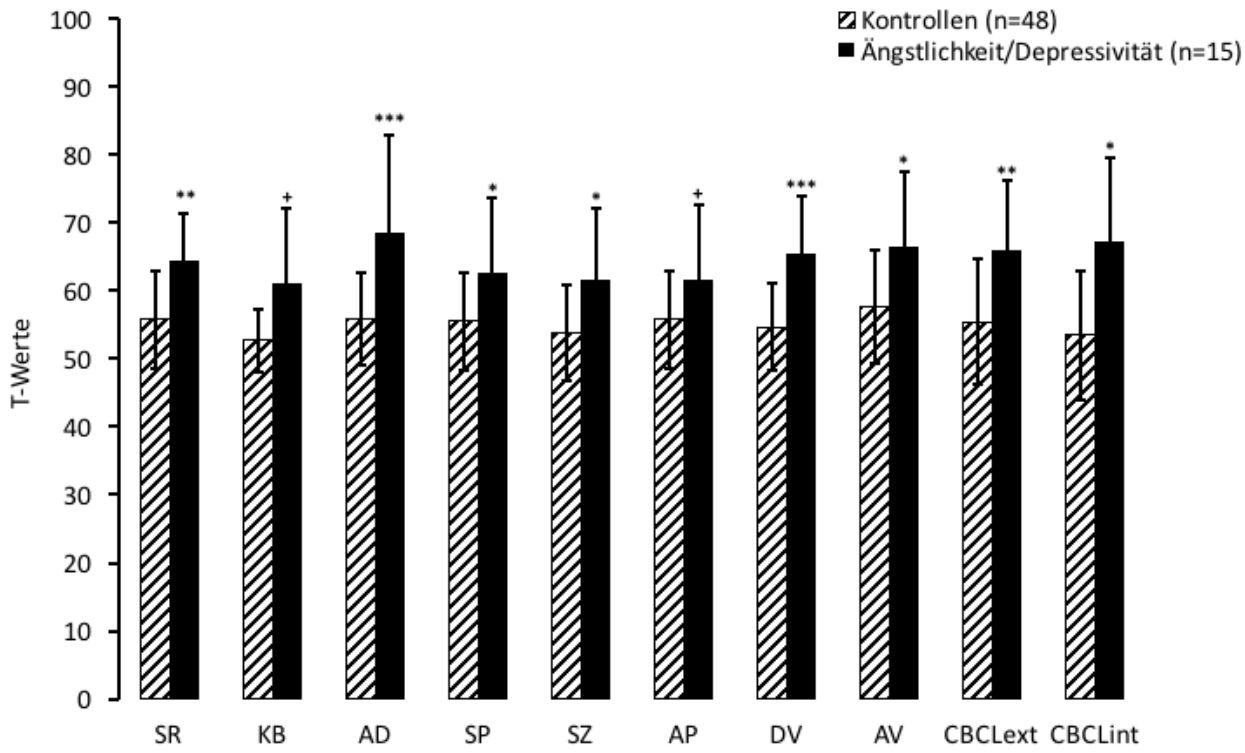

Abbildung 1. Gruppenunterschiede hinsichtlich der CBCL Subskalen zwischen Müttern mit und ohne erhöhte Angst/Depressionssymptome.

Anmerkungen: SR = sozialer Rückzug, KB = körperliche Beschwerden, AD = ängstlich-depressiv, SP = soziale Probleme, SZ = schizoid-zwanghaft, AP = Aufmerksamkeitsprobleme, DV = dissoziales Verhalten, AV = aggressives Verhalten
+ p< .10, * p< .05, ** p< .01, *** p< .001.

Mütterliche psychische Symptome und Interaktionsverhalten

Auch das Interaktionsverhalten bzw. die Qualität der Mutter-Kind-Interaktion wurde mit Hilfe von T-Tests für unabhängige Stichproben mit der Gruppenvariable „Angst/Depression“ untersucht. Die abhängigen Variablen sind die in Tabelle 1 dargestellten 5 Merkmale der Mutter-Kind-Interaktion. Wie aus Abbildung 2 erkennbar, unterscheiden sich die zwei Gruppen auf den Skalen Feinfühligkeit, Strukturierung, Bezogenheit und Harmonie statistisch signifikant. In den Mutter-Kind-Dyaden, bei denen die Mutter erhöhte Angst und/oder Depressionsscores aufwiesen, waren die Werte der Interaktionsskalen niedriger, was auf eine geringere Qualität der Interaktionen hindeutet.

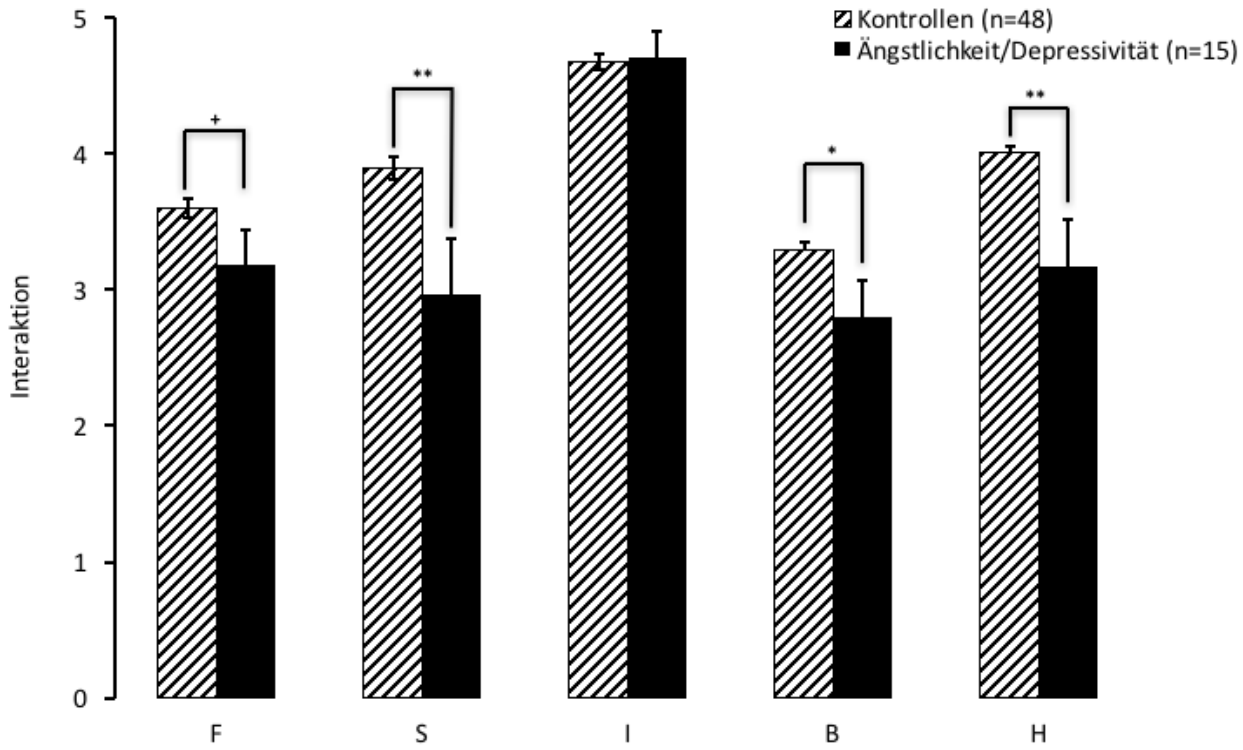

Abbildung 2. Gruppenunterschiede im Interaktionsverhalten zwischen Müttern mit und ohne erhöhte Angst/Depressionssymptome.

Anmerkungen: F=Feinfühligkeit=Strukturierung,I=Intrusivität,H=Harmonie,B=Bezogenheit
+ p< .10, * p< .05, ** p< .01, *** p< .001.

Die Gruppenunterschiede der vier Interaktionsskalen lagen zwischen 0.49 (Bezogenheit; *Cohens d = 0.74*) und .92 (Strukturierung; *Cohens d = 1.84*) Punkten.

Externalisierende Auffälligkeiten als Folge mütterlicher psychischer Symptome und Merkmalen der Mutter-Kind-Interaktion

Mittels regressionsanalytischer Verfahren wurde der moderierende Einfluss von Interaktionsmerkmalen auf externalisierende Verhaltensprobleme ($CBCL_{ext}$) untersucht. Die Ergebnisse der Regressionsanalysen zeigen, dass in Hinblick auf die externalisierenden Symptome von Kindern nur die mütterlichen psychischen Symptome, nicht aber Merkmale der Mutter-Kind-Interaktion, prädiktiv waren (vgl. Tabelle 2). Hohe GSI Werte der Mütter sagten auch hohe Werte auf der CBCL Subskala „Externalisierende Auffälligkeiten“ vorher

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(R^2 = *.130; Beta = .360, p = .006*). Somit klärte die psychische Belastung der Mütter 13% der Varianz die externalisierenden Symptome der Kinder auf.

Tabelle 2

Ergebnisse der Regressionsanalysen zur Vorhersage Externalisierende Störungen ($CBCL_{ext}$)

	B	**R^2**	**ΔR^2**	**F**	**ΔF**
Step 1: Mütterliche psychische Symptome (GSI)	*.360***	*.130*	*.130*	*8.938*	*8.938 **
Step 2: Mutter-Kind-Interaktion					
(1) Feinfühligkeit	*-.162 n.s.*		*.026*		*1.835 n.s.*
(2) Strukturierung	*-.066 n.s.*		*.004*		*.280 n.s.*
(3) Intrusivität	*.003 n.s.*		*.000*		*.000 n.s.*
(4) Harmonie	*-.206 n.s.*		*.034*		*2.417 n.s.*
(5) Bezogenheit	*-.188 n.s.*		*.034*		*2.389 n.s.*
Step 3: Interaktionsterm					
(1) GSIxFeinfühligkeit	*-0.47 n.s.*		*.002*		*.136 n.s.*
(2) GSIxStrukturierung	*-.180 n.s.*		*.024*		*1.685 n.s.*
(3) GSIxIntrusivität	*.118 n.s.*		*.012*		*.826 n.s.*
(4) GSIxHarmonie	*.083 n.s.*		*.003*		*0.242 n.s.*
(5) GSIxBezogenheit	*.038 n.s.*		*.001*		*.072 n.s.*

n.s. = not significant * p ≤ .05. **p ≤ .01. ***p ≤ .001.

Internalisierende Auffälligkeiten als Folge mütterlicher psychischer Symptome und Merkmalen der Mutter-Kind-Interaktion

Auch in Bezug auf die internalisierenden Symptome der Kinder ($CBCL_{int}$) klärte im regressionsanalytischen Modell die psychische Belastung der Mütter (GSI) einen erheblichen Anteil an Varianz auf (14.5%). Wie in Tabelle 2 dargestellt, hatten neben den psychischen Symptomen der Mütter, auch Merkmale der Mutter-Kind-Interaktion (mütterliche Feinfühligkeit, Intrusivität und Harmonie) prädiktive Vorhersagekraft in Bezug auf

internalisierende Symptome der Kinder. Diese Variablen erklärten zusätzlich zwischen 4.8% und 6.8% der Variabilität der $CBCL_{int}$ Werte. Die standardisierten Beta-Gewichte machen deutlich, dass die $CBCL_{int}$-Werte der Kinder auf der Subskala „Internalisierende Auffälligkeiten“ um so höher waren, je geringer die Qualität der Mutter-Kind-Interaktion (Harmonie) bzw. des mütterlichen Interaktionsverhaltens (Feinfühligkeit, Intrusivität) beurteilt wurde. Mütterliches Strukturierungsverhalten und die Bezogenheit des Kindes hatte in der vorliegenden Studie keinen Effekt auf die Ausprägung internalisierender Symptome bei Vorschulkindern.

Tabelle 3

Ergebnisse der Regressionsanalysen zur Vorhersage Externalisierende Störungen ($CBCL_{int}$)

	B	**R^2**	**ΔR^2**	**F**	**ΔF**
Step 1: Mütterliche psychische Symptome (GSI)	*.360***	*.145*	*.145*	*10.499*	*10.499* **
Step 2: Mutter-Kind-Interaktion					
(6) Feinfühligkeit	*-.220* *		*.048*		*3.618* *
(7) Strukturierung	*-.138* $^{n.s.}$		*.018* $^{n.s.}$		*1.315* $^{n.s.}$
(8) Intrusivität	*-.263* *		*.068*		*5.245* *
(9) Harmonie	*-.225* *		*.042*		*3.189* *
(10) Bezogenheit	*-.188* $^{n.s.}$		*.034*		*2.551* $^{n.s.}$
Step 3: Interaktionsterm					
(6) GSIxFeinfühligkeit	*-0.024* $^{n.s.}$		*.001*		*.038* $^{n.s.}$
(7) GSIxStrukturierung	*-.144* $^{n.s.}$		*.016*		*1.134* $^{n.s.}$
(8) GSIxIntrusivität	*.220* *		*.043*		*3.424* *
(9) GSIxHarmonie	*.010* $^{n.s.}$		*.000*		*0.004* $^{n.s.}$
(10) GSIxBezogenheit	*.038* $^{n.s.}$		*.000*		*.017* $^{n.s.}$

n.s. = not significant * p ≤ .05. **p ≤ .01. ***p ≤ .001.

Zusätzlich gab es, wie in Abbildung 3 dargestellt, in Bezug auf die mütterliche Intrusivität einen Mediatoreffekt.

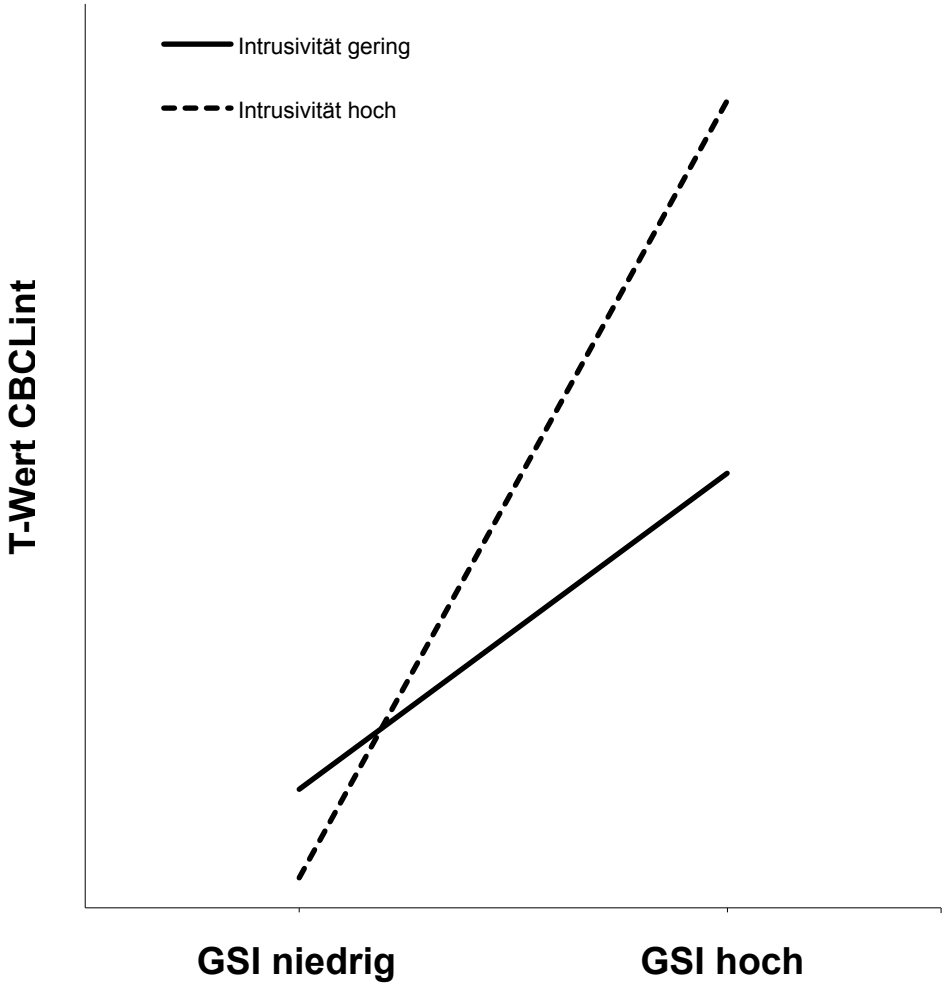

Abbildung 3. Grafische Darstellung des regressionsanalytisch gefundenen Mediatoreffekts von mütterlicher Intrusivität auf den Zusammenhang zwischen psychischer Belastung der Mutter und internalisierenden Symptomen des Kindes.

Bei den Kindern von Müttern mit eher niedriger psychischer Belastung, sind nur wenige Symptome internalisierender Störungen zu finden. Das intrusive Verhalten der Mütter hatte zudem kaum einen Effekt auf die Ausprägung der $CBCL_{int}$-Werte. Bei Kindern von Müttern mit einer hohen psychischen Belastung, sind die internalisierenden Symptome wesentlich stärker ausgeprägt. Wenn diese Mütter sich zusätzlich noch sehr intrusiv verhielten, waren die $CBCL_{int}$-Werte jedoch deutlich erhöht.

Diskussion

Die vorliegenden Ergebnisse zeigen, dass sowohl internalisierende als auch externalisierende Verhaltensauffälligkeiten bei Vorschulkinder im Zusammenhang mit psychischen Problemen ihrer Mütter stehen. Mütter mit klinisch bedeutsamen Werten an Ängstlichkeit/Depressivität hatten Kinder, die vermehrt Verhaltensauffälligkeiten bzw. emotionale Probleme aufwiesen. Sowohl internalisierende als auch externalisierende Symptome bei ihren Kindern wurden von Müttern mit erhöhten Angst- bzw. Depressionswerten berichtet. Dieses Ergebnis steht im Einklang mit einer Vielzahl vorangegangener Befunde (u.a. Agnafors et al., 2016; Breaux et al., 2014; Micco et al., 2009).

Weiterhin wiesen Mütter mit hohen psychischen Belastungen in einer standardisierten Verhaltensbeobachtung eine geringere Feinfühligkeit auf. Sie waren weniger aufmerksam gegenüber den Signalen ihres Kindes (z.B. von Überforderung) und reagierten weniger angemessen auf kindliche Bedürfniszeichen. In Bezug auf die Strukturierung der Interaktionssituation zeigte sich bei Müttern mit höheren Angst/Depressionswerten eine geringere Unterstützung des Kindes. Sie setzten weniger Grenzen und waren in ihrem Führungsverhalten weniger angemessen. Die Interaktion mit ihren Kindern wurde als insgesamt weniger harmonisch bzw. positiv eingeschätzt und die Kinder zeigten weniger Responsivität auf Interaktionsangebote ihrer Mütter. Auch diese Befunde replizieren bereits vorangegangene Studienergebnisse (Harvey, Stoessel, & Herbert, 2011; Kluczniok et al., 2016; Leckman-Westin, Cohen, & Stueve, 2009). So berichten beispielsweise Schneider et al. (2009) von mehr verbaler Kontrolle, mehr Kritik und weniger sensitiven Interaktionen bei Müttern mit Panikstörungen.

Entgegen unserer Hypothese, hatte nur die psychische Gesamtbelastung der Mütter, nicht aber ihr Interaktionsverhalten bzw. die Qualität der Interaktion in einer standardisierten Verhaltensbeobachtung einen Effekt auf die Ausprägung externalisierender Symptome im Vorschulalter. Dieser Befund steht im Kontrast zu anderen Studien, welche bei Kindern mit externalisierenden Störungen gestörte Mutter-Kind-Interaktionen fanden. So beschreiben beispielsweise Stormshak, Bierman, McMahon und Lengua (2000) bei Eltern von Kindern mit ADHS bzw. einer Störung des Sozialverhaltens eine höhere Bereitschaft zur Anwendung restriktiver, harscher und punitiver Erziehungsmethoden mit weniger liebevollen Steuerungsstrategien.

Villodas et al. (2015) wiederum beschreiben, dass mütterliche Depressionen zu vermehrten aggressiven Verhaltensweisen der Mütter beiträgt, was wiederum ein häufig berichteter Risikofaktor für externalisierende Störungen ist. Die Tatsache, dass wir in der vorliegenden Studie keinen Zusammenhang zwischen mütterlichem Interaktionsverhalten bzw. der Qualität der Mutter-Kind-Interaktion und externalisierenden kindlichen Symptomen gefunden haben, lässt sich möglicherweise methodisch erklären. So wurde in unserer Studie nicht explizit strafendes bzw. aggressives Verhalten der Mütter erfasst. Es ist zwar denkbar, dass in den Beobachtungsskalen „Harmonie“ und „Intrusivität“ Aspekte mütterlicher Aggressivität bzw. harscher Erziehungspraktiken einfließen, jedoch wurden diese Verhaltensdimensionen nicht unabhängig beobachtet. Eine andere Erklärungsmöglichkeit könnte sein, dass die Beobachtungssituation für die Kinder, welche im Alltag wiederholt externalisierende Auffälligkeiten zeigen, nicht lang genug war, um diese Verhaltensprobleme auch in der Laborsituation zu induzieren, so dass die Mütter seltener mit dysfunktionalen Interaktionsstilen auf ihre Kinder reagierten. Jedoch gab es auch andere Studien, welche keinen moderierenden Effekt der Mutter-Kind-Interaktion auf externalisierende Symptome fanden. Bei van Doorn et al. (2016) waren die depressiven Symptome von Müttern mit höheren Werten an psychologischer Kontrolle assoziiert, jedoch fand sich kein Interaktionseffekt zwischen dem Verhalten der Mutter und psychischen Symptomen des Kindes.

Bei den internalisierenden Symptomen zeigte sich in unserer Studie jedoch, dass neben der psychischen Belastung der Mutter, auch ihr interaktionelles Verhalten kindliche internalisierende Symptome (Ängste, sozialer Rückzug, Depressivität) im Vorschulalter vorhersagte. Diese Befunde decken sich mit Studien zur transgenerationalen Weitergabe von Angststörungen. So haben beispielsweise Murray und Kollegen in mehreren Untersuchungen zeigen können, dass das Verhalten von Kleinkindern gegenüber unvertrauten Personen maßgeblich vom zuvor beobachteten Verhalten der eigenen Mutter gegenüber einer fremden Person abhängt (Murray et al., 2008). Zeigten sich die Mütter ängstlicher in der sozialen Interaktion reagierten auch ihre Kinder ängstlicher. Zalewski et al. (2015) wiederum beschreiben einen moderierenden Effekt mütterlicher Zurückweisung auf internalisierende Symptome bei Kindern in der Präadoleszenz.

Die vorliegenden Ergebnisse betonen die Bedeutung der psychischen Gesundheit von Müttern bei der Entwicklung von Verhaltensauffälligkeiten ihrer Kinder. Weiterhin wird deutlich, dass insbesondere bei

internalisierenden Störungen das Interaktionsverhalten der Mütter eine wichtige Rolle für die Entstehung und Aufrechterhaltung zu haben scheint. Indem sich Mütter in die Gefühlswelt ihrer Kinder versetzen, gelingt es ihnen, die Bedürfnisse des Kindes zu erkennen und entsprechend zu handeln. Dabei ist vor allem die Fähigkeit zur Perspektivübernahme und eine realistische Wahrnehmung und Einschätzung der kindlichen Kompetenzen und Bedürfnisse vor dem Hintergrund seines jeweiligen Entwicklungsstandes wichtig. Emotionaler Stress von Müttern kann jedoch zu einer verzerrten Wahrnehmung des Kindes führen und damit zu vermehrten negative Emotionen auf Seiten der Mütter. So reduzieren beispielsweise verärgerte oder wütende Emotionen von Müttern angemessene proaktive Steuerungsstrategien bei ihren Kindern (Denham et al., 2000), was sich wiederum negativ auf die Entwicklung angemessener Emotionsregulationsstrategien auswirkt. Defizite in der Emotionsregulation wiederum stellen einen Risikofaktor für psychische Störungen dar, denn die angemessene Steuerung von Emotionen ist die Voraussetzung für soziale Kompetenz und sozial angemessenes Verhalten. Durch Prozesse des Modelllernens, des *Matching* und der Co-Regulation entwickelt sich bei einem Kind das Emotionsverständnis und die Emotionsexpression, welche wiederum Voraussetzung für die Regulation von Emotionen sind (Denham, 1998). In der vorliegenden Studie wurde die Emotionsregulation der Kinder nicht direkt erfasst, sondern nur emotionale und Verhaltensprobleme. Deshalb wären in einem weiteren Schritt detailliertere Untersuchungen hinsichtlich des Zusammenhangs zwischen mütterlicher Psychopathologie, Interaktionsverhalten, Emotionsregulation und kindlicher Psychopathologie wünschenswert.

Dass das Interaktionsverhalten von Eltern nicht unabhängig von kindlichen Merkmalen ist, haben Klein et al. (2016) nachweisen können. Die Autoren beobachteten während zweier Laboruntersuchungen (im Alter von 3 und 4,5 Jahren) mit insgesamt 306 Kindern und ihren Müttern das Temperament und das mütterliche Erziehungsverhalten. Zudem wurde die kindliche Anpassungsfähigkeit (im Altern von 3 und 5 Jahren) durch Kindergärtnerinnen beurteilt. Ihre Ergebnisse legen nahe, dass es bidirektionale Verbindungen zwischen dem mütterlichen Erziehungsverhalten (Wärme, Grenzsetzung etc.), kindlichen Temperamentsmerkmalen bzw. kindlicher Emotionsregulation und Verhaltensproblemen des Kindes gibt. So sagte beispielsweise mütterliche Negativität kindliche Frustrationstoleranz vorher. Jedoch gab es auch Wechselwirkungen zwischen mütterlicher Negativität und kindlicher *effort control*, einer temperamentsbasierten Kapazität zur Selbstregulation, was

wiederum eine Voraussetzung zur erfolgreichen Aufmerksamkeitslenkung und Unterdrückung von unangemessenem Verhalten ist. Ähnliches fanden auch Harvey, Stoessel und Herbert (2011). Sie untersuchten den Effekt psychischer Erkrankungen von Müttern auf deren Erziehungsverhalten und stellten dabei fest, dass sowohl Depressionen, Angsterkrankungen, Substanzmissbrauch als auch Persönlichkeitsstörungen mit einer höheren Ausprägung an Laissez-fairem Erziehungsverhalten, Negativität und mangelnder Wärme verbunden waren. Wenn Mütter in ihrem Verhalten weniger sensitiv, gleichzeitig aber auch eher intrusiv sind, kann dies die Entwicklung von eigenen Strategien zur Bewältigung von negativen Emotionen wie Angst oder Traurigkeit behindern. Auch dies könnte, die von uns gefundenen Zusammenhänge zwischen mütterlichen Symptomen, Interaktionsverhalten und kindlichen Schwierigkeiten erklären.

Limitationen

Bei der Bewertung der oben genannten Befunde müssen einige methodische Einschränkungen beachtet werden. Eine der größten Einschränkungen ist, dass es sich bei der vorliegenden Studie um ein Querschnittsdesign handelt. Da mütterliche und kindliche Verhaltensauffälligkeiten zur gleichen Zeit erhoben wurden, können nur Assoziationen, nicht aber kausale Verknüpfungen identifiziert werden. So könnte eine hohe psychische Belastung der Mutter genauso gut auch Folge der Verhaltensprobleme ihres Kindes sein und nicht Ursache. In diesem Kontext ist auch die nächste Limitation zu sehen, denn sowohl die Selbsteinschätzung eigener psychischer Probleme als auch die ihrer Kinder erfolgte durch die Mütter selbst. Hierbei kann es zu Verzerrungen, vor allem der kindlichen Verhaltensprobleme kommen, wenn die Mutter an einer psychischen Erkrankung leidet (Müller, Romer, & Achtergarde, 2014). Auf der anderen Seite ist es denkbar, dass Mütter aus Scham eigene Probleme verschwiegen haben. Dies könnte unter anderem auch die Limitation erklären, dass in der vorliegenden Studie der Gesamtbelastungsscore des BSI bei keiner Mutter über dem klinischen Cut-off lag. Somit war es nicht möglich, den GSI als Gruppenvariable für die T-Tests zu verwenden. Wir mussten stattdessen die Gruppeneinteilung auf der Basis von Ängsten bzw. Depressionen vornehmen. Hierzu kann entkräftend angeführt werden, dass eine Vielzahl anderer Studien sich ausschließlich mit dem Effekt von mütterlichen Depressionen und Angststörungen auf die psychische Gesundheit ihrer Kinder beschäftigt haben. Auch zeigten explorative Analysen einen sehr engen und hochsignifikanten Zusammenhang zwischen den BSI

Subskalen „Ängste“ und „Depressionen“ und dem Gesamtbelastungsscore GSI. In den Regressionsmodellen wurde deshalb der GSI als kontinuierliche Variable verwendet. Es zeigten sich die gleichen Zusammenhänge zwischen psychischen Symptomen der Mütter und Verhaltensproblemen ihrer Kinder.

Weiterhin wurden im Rahmen der vorliegenden Studie nicht explizit Mütter mit psychischen Erkrankungen rekrutiert, so dass nicht per se von hohen psychischen Belastungen der teilnehmenden Mütter ausgegangen werden konnte. Eine weitere Einschränkung ist die Tatsache, dass wir nur Mütter untersucht haben. Somit kann keine Aussage zum Einfluss der Väter gemacht werden.

Auch die relativ geringe Stichprobengrösse ist eine methodische Einschränkung da komplexere statistische Modelle nicht berechnet werden konnten. Eine geringere Stichprobengröße bedeutet auch eine geringere Power der statistischen Tests, so dass das Risiko steigt, dass tatsächlich vorhandene Effekte übersehen werden. In der vorliegenden Studie konnte jedoch trotz geringerer Power gezeigt werden, dass psychische Symptome von Müttern mit externalisierenden und internalisierenden Symptomen ihrer Kinder zusammenhängen. Außerdem waren wir in der Lage mütterliches Interaktionsverhalten bzw. die Qualität der Mutter-Kind-Interaktion als einen möglichen ätiologischen Faktor bei internalisierenden Verhaltensauffälligkeiten im Vorschulalter zu identifizieren.

Klinische Implikationen der Befunde

Die vorliegende Studie konnte aufzeigen, dass besonders belastete Mütter eher Kinder mit psychischen Problemen haben. Auch wenn es sich bei diesem Befund nicht um einen kausalen Zusammenhang handelt, könnte ein frühzeitiges Screening von Müttern hinsichtlich ihrer psychischen Gesundheit die Auftretenswahrscheinlichkeit für Verhaltensprobleme bei ihren Kindern reduzieren, da dadurch früher Entlastungsmöglichkeiten angeboten werden können, um ungünstige Interaktionen zu verhindern. Dies trifft insbesondere dann zu, wenn die daraus folgenden Unterstützungsangebote zu einer Reduktion des Stresslevels der Mütter führt und sich damit auch die Reaktionen der Mütter auf ihr Kind verändern. Hausärzte sollten deshalb bei Eltern von Kindern im Vorschulalter für diese Thematik sensibilisiert werden und regelmäßig nach psychischen Symptomen fragen. Auch lässt sich aus den Befunden ableiten, dass bei der Behandlung psychischer Probleme im Vorschulalter der Focus nicht nur auf dem Kind, sondern auch auf einer baldigen

Entlastung bzw. Mitbehandlung der psychischen Symptome der Mütter liegen sollte. Dem Konzept von Papousek (2004) folgend, dürfen die Symptome von Kindern nicht isoliert betrachtet und behandelt werden, sondern sollten immer im Kontext von Überlastungssymptomen bzw. psychischen Erkrankungen der Eltern und daraus folgend möglichen dysfunktionalen Interaktionen betrachtet werden. Dies würde für die Praxis bedeuten, dass insbesondere bei sehr jungen Kindern, zuerst Entlastungsmaßnahmen für die Mütter/Eltern etabliert werden müssen, um anschließend die Verhaltensauffälligkeiten des Kindes behandeln zu können. Es konnte auch gezeigt werden, dass Kinder, beispielsweise von depressiven Eltern, welche insgesamt über geringere soziale Kompetenzen verfügten, deutlich von einer frühen Förderung emotionaler Fertigkeiten profitieren (Izard et al., 2008; Johnson, Seidenfeld, Izard, & Kobak, 2013). Durch gezielte Programme für Hochrisikokinder (z.B. Kinder psychisch kranker Eltern) zum Aufbau des Emotionsverständnisses und der Emotionsexpression könnte somit das Auftretensrisiko von externalisierenden und internalisierenden Störungen im Kindesalter vermindert werden.

Weiterhin wurde dargestellt, dass die Qualität von Interaktionen zwischen psychisch stark belasteten Müttern und ihren Kindern im Vorschulalter niedriger ist und dass, insbesondere in Hinblick auf internalisierende Störungen, solche interaktionellen Defizite zu einer Verstärkung der kindlichen Symptome führen können. Daraus lässt sich für die Praxis ableiten, dass insbesondere bei Vorschulkindern das Augenmerk auf die Verbesserung der mütterlichen Sensitivität bzw. den Abbau von intrusivem Verhalten liegen sollte. Somit scheint es empfehlenswert in die Behandlung von jungen Kindern, neben symptomorientierten Techniken, auch z.B. spieltherapeutische oder interaktionszentrierte Techniken einfließen zu lassen (z.B. im Rahmen einer Parent-Child-Interaction-Therapie, PCIT). Ziel sollte dabei, neben der Symptomreduktion, auch die Verbesserung der Mutter-Kind-Interaktionen sein.

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Chapter 3 Maternal health problems such as depression and anxiety and parent-child interaction

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Abstract

Background

The emotional climate between mothers and their children is known to be a significant indicator for the development of childhood psychopathology. One index that allows measuring family-emotional climate is the expressed emotion measure (EE). Maternal mental strain is known to affect maternal EE, as it can shape the way a mother thinks about, and interacts with her child.

Context and purpose of the study

The main objective of our study was to highlight the links between maternal EE, mother-child interaction and maternal mental problems on behavior problems in children.

Data were examined from 49 children aged 5 to 7 and their mothers. The Five-Minute Speech Sample (FMSS) was used to evaluate maternal EE. Behavioral disorders have been assessed with the German version of the Child Behavior Checklist (CBCL-4/18). To evaluate maternal symptoms of psychopathology, we used the German version of the Brief Symptoms Inventory (BSI). The quality of the mother–child interaction was observed during a standardized problem-solving task.

Results

High maternal criticism was linked to more child psychopathology, more maternal mental health problems, less maternal sensitivity and less responsiveness in children during the interactional task. The effect of maternal mental problems on externalizing problems in children was mediated by high criticism in mothers.

Conclusions

The results highlight noteworthy links between mother's criticism, child psychopathology and mother-child interactional patterns. According to our results, intervention programs focusing on children, mother-child-interaction and maternal psychopathology seem to be of major importance.

Keywords: Child psychopathology; Expressed emotion; Mother-child interaction; Maternal psychopathology

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Background

There is convincing evidence indicating that parental mental problems substantially raise the risk for emotional and behavioral problems in their children (Stein et al., 2014). In addition, it was shown that parental mental health problems negatively impact parenting and parent-child interaction (Reupert, J Maybery, & Kowalenko, 2013). Whereas proactive parenting characterized by clear instruction, limit setting and supportive presence longitudinally predicted fewer behavior problems over time in children with disruptive behavior disorder, parental anger predicted a continuation of problem behavior (Denham et al., 2000). Thus, parental-driven factors, especially mental illness and negative parenting seem to be one of the most important risk factors in the development of childhood mental health problems.

However, up to now it is not sufficiently investigated whether parental mental health problems are associated directly with child mental problems or whether this association might be mediated by parental expressed emotion towards the child (Bolton et al., 2003; Gravener et al., 2012; Denise R Nelson et al., 2003). The assumption underlying the concept of expressed emotion (EE) is that the way parents talk about their child is indicative of the way they treat their child in daily-life and thus is an index of the emotional quality of the parent-child relationship and -interaction (G. W. Brown, E. Monck, G. M. Carstairs, & J. K. Wing, 1962). According to Brown et al. (1962) EE includes a critical (EE CRIT) and an emotional over-involvement dimension (EOI). EE CRIT comprises possible negative comments from the parent talking about their child and is indicative for possible negative relationship structure. EOI refers to the level of emotional over-involvement between parent and child, including self-sacrificing and overprotective behavior. High levels of parental EE have consistently been associated with externalizing behavior, ADHD and conduct disorders (Baker et al., 2000; Caspi et al., 2004; Musser et al., 2016; Peris & Hinshaw, 2003). Additionally, high rates of EE have also been found in parents of children with internalizing disorders, e.g. depression (Asarnow et al., 2001; Rogosch et al., 2004; Silk et al., 2009), anxiety disorders (Stern, 2003) and self-injurious thoughts or behaviors (Wedig & Nock, 2007). Moreover, there is evidence indicating that EE is associated with depression in mothers (Gravener et al., 2012; Tompson et al., 2010). Whereas EE might be a key mechanism of risk transmission, it was not yet investigated whether EE directly impacts parental-child interaction. Thus, the main objective of this

study was to investigate whether in mothers with high EE the mother-child interaction is negatively affected and whether EE is associated to other mental problems in mothers besides depression. In order to assess objective indices of the mother-child interaction (e. g. maternal sensitivity, child responsiveness) a structured problem-solving task was used. Second, based on previous literature we further investigated whether maternal EE is associated both with externalizing and internalizing behavior symptoms. Moreover, we examined if mothers with high EE differ in mental health problems. Finally, we tested whether the association between maternal and child mental health problems is mediated by maternal EE towards the child.

Materials and Methods

Procedure

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee. The study protocol was approved by the ethics committee of Basel (EKBB) and is consistent with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. No funding was received.

In order to recruit children varying in the level of emotional and behavioral problems, recruitment was conducted both in community and clinical settings via newspapers and flyers. Subjects were included if the mother could communicate in German sufficiently, and the child was 5 to 7 years of age. To ensure comparability and understanding of tasks, children with a history of a pervasive developmental disorder were not included.

After giving informed consent, mothers and their children were asked to participate in a structured problem-solving task to assess the quality of dyadic interaction. EE was assessed by the Five-Minute Speech Sample (FMSS). Questionnaires on maternal and child mental health problems were provided to the mothers after completing the FMSS.

Sample description

The participants included a total of 49 children and their mothers. The mean age of the children was 6.5 (SD =

1.2) years, 66.7% were boys and had primarily (70%) Swiss or European Union citizenship. The mean age of the mothers was 37.5 (SD = 5.6) years. About 67% of mothers were married or lived with their partner and 85% had 10 or more years of schooling.

The data of participants was excluded when screening data on maternal or child mental health problems was missing or incomplete. Furthermore, some FMSS videos could not be rated because of technical problems during recording. Finally, 49 mother-child interaction dyads could be included in the analyses.

In a preliminary analysis, we examined whether EE categories (EE CRIT / EOI) were related to the socioeconomic patterns of the family (financial situation, apartment size, number of siblings in household, years of schooling, etc.), demographic characteristics (sex, age, nationality, etc.) or any child or mother variables of the study, to address the need for potential control variables in subsequent analyses. Child age, gender, and nationality were not significantly associated with any of the study variables.

Children's behavioral and emotional problems regarding externalizing behavior symptoms ranged from T=50 to T=83 (M=57, SD=10) and internalizing behavior symptoms from T= 50 to T= 78 (M=55, SD=11). Of the 49 dyads, 37 (75.5%) mothers were rated as having low EE CRIT and 12 (24.5%) mothers were rated as having high EE CRIT. EE CRIT was unrelated to demographic variables, including family structure (single vs. dual parent family), child sex or age, mother's age or mother's level of education. All ratings were based on EE CRIT. No mother in our sample displayed EOI during the FMSS.

Measures

Behavioral and Emotional Problems of the children (CBCL)

Behavioral disorders were assessed using the German version of the Child Behavior Checklist (CBCL-4/18) (Achenbach & Rescorla, 2001). The CBCL-4/18 allows an assessment to be made of behavioral and emotional abnormalities, as well as somatic complaints using eight symptom scales: Withdrawn, Somatic Complaints, Anxious/Depressed, Social Problems, Thought Problems, Attention Problems, Rule-breaking Behavior and Aggressive Behavior. From these scales, an Internalizing Problems Index, an Externalizing Problems Index and a Total Score can be derived. The CBCL scales showed good internal consistencies ($\alpha \geq .93$).

Mental problems of the mother (BSI)

To evaluate a broad range of psychological problems in mothers, we used the German version of the Brief Symptoms Inventory (BSI) (Spitzer et al., 2011). The BSI is the short version of the Symptom Checklist-90-R (SCL-R-90) (Derogatis, Rickels, & Rock, 1976), which consists of 53 items, covering nine symptom dimensions: Somatization, Obsession-Compulsion, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic anxiety, Paranoid ideation, Psychoticism and a Global Severity Index.

Expressed Emotion (EE)

EE was measured using the Five-Minute Speech Sample (FMSS) (Magaña et al., 1986). Trained interviewers asked the mothers to describe their relationship with the child and what their child is like in a five-minute monologue (e.g., "For the next 5 minutes, I would like you to describe [name of child] to me; what is he/she like?", "How would you describe your relationship with each other?"). The mother was encouraged to talk freely with no interruptions. However, if the mother found this difficult, the interviewer could aid the mother with a series of semi-structured probes.

According to the most updated FMSS coding manual (Magana-Amato, 1993), high expressed emotion criticism (EE CRIT) was scored as present if there was a negative relationship rating or if there were one or more critical statements/negative tone of voice about the child. A negative relationship was rated if there was a statement indicating that the mother and the child did not get along (e.g., if the mother said, "My child is impossible to deal with"). Critical comments are negative comments about the child's behavior or personality and they were scored on the basis of critical content and/or critical tone. Criticisms based on the content were scored, when the child's behavior or characteristics were described by the mother with a critical phrase (e.g., " I don't like the way he dresses") or in a negative manner (e.g., "she is very self-centered"). Similarly, criticisms were scored if there was harsh voice even in the absence of critical content.

EOI rating refers to the level of emotional over-involvement between mother and child. High EOI was rated as present, if there was self-sacrificing/overprotective behavior or emotional display during the interview. Self-sacrificing/overprotective behavior was scored as present, when the mother reported extreme or unusual sacrifice (e.g., "I don't spend that much money on things for myself so that I can give it to my son"), examples

of extreme enmeshment (e.g., " We're so close, I just don't want her to grow up") or extreme or unusual over-protection (e.g., "Even though he is ten years old, I like him to be in front of my eyes all the time, even when he is playing with his friends"). Next, emotional display was rated as present when the mother cried or was unable to speak during the interview due to emotional sentiment.

To ensure reliability, every videotaped EE interview was scored independently by two well-trained raters. Inter-rater reliability was moderate (Kappa = 0.42).

Mother-Child Interaction

According to Wolke, Rios, and Unzer (1995), the quality of the mother–child interaction was observed during a standardized problem-solving task. We used an Etch-a-Sketch, a toy that allows for the sketching of pictures by turning two buttons: one allows horizontal lines and the other vertical lines to be drawn. We asked each mother-child dyad to copy a house according to a template. Each interaction partner was allowed to use only one of the buttons. This should induce coordinative communication between mother and child. All interactions were videotaped and were stopped by the experimenter after 5 minutes.

To assess the quality of parent-child interactions a coding system developed on the concept of emotional availability (Biringen & Robinson, 1991) and Bowlby´ s attachment theory (Bowlby, Ainsworth, Boston, & Rosenbluth, 1956) comprising three maternal dimensions (sensitivity, structuring and intrusiveness), one child dimension (child responsiveness) and one dimension concerning the quality of interaction (harmony and warmth) was applied (see Table 1). To ensure reliability, every videotaped mother-child interaction was scored independently by two well-trained raters. Inter-rater-reliability was very good (Kappa 0.78 to 0.92.).

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Table 1
Mother-Child-Interaction Scales

Interactional scales	Description	Scale
Harmony and Warmth	The amount of conflict in the mother-child-interaction	1 = many conflicts 5 = great harmony
Structuring	The mother's ability to structure the interaction appropriately to child age and needs	1 = no structuring at all or too much structuring 5 = appropriate structuring
Sensitivity	Mother's capacity to perceive and interpret infant emotions accurately and to respond to them appropriately	1 = Low maternal sensitivity 5 = High sensitivity
Intrusiveness	The degree to which the mother interferes with the child's autonomy and space	1 = No maternal intrusiveness 2 = High maternal intrusiveness
Responsiveness	Indicates how well the child responds to the mother's bids and structuring behavior	1 = Low responding child 5 = High responding child

Data Analysis

The data was analyzed using SPSS statistical software for Windows, release 22 (SPSS Inc., Chicago, Illinois).

First, in order to investigate whether mother and child interactional behaviors differ in high and low maternal EE CRIT, we performed a one-way analysis of variance between groups (ANOVA). Using the same statistical procedures, we examined the association between child emotional and behavioral problems (CBCL) and maternal mental health problems (BSI) on maternal EE occurrence. Investigating the link between child problems and EE CRIT, we controlled for maternal mental problems (ANCOVA). Finally, to determine the mediating effect of EE CRIT on the association between maternal psychopathology and children´s behavioral problems, we ran a linear regression analysis.

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Results

Association between maternal expressed emotion criticism and mother-child interactional behaviors

Result of the conducted ANOVA indicate that children of mothers expressing high levels of EE CRIT were less responsive (F = 5.20, p = 0.03, d = 0.37) to their mothers and that there was significantly less harmony and warmth during the interaction (F = 4.55, p = 0.038, d = 0.71). In addition, there was a trend showing that mothers expressing high rates of criticism were rated as acting less sensitively (F = 4.18; p = 0.05; d = 0.56) towards their children (see Fig. 1).

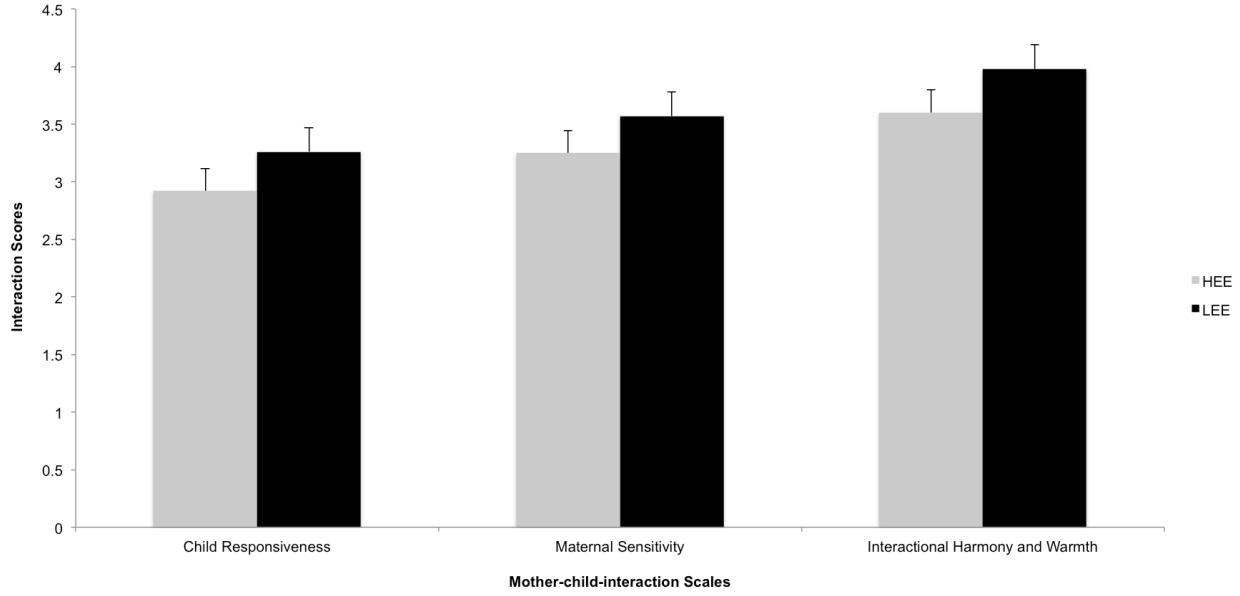

Figure 1. Association between maternal expressed emotion criticism and mother-child interactional behaviors

There was no significant group difference regarding maternal structuring behavior or maternal intrusiveness.

Association between maternal expressed emotion criticism and internalizing and externalizing problems of the child

Results further indicate that children of mothers who showed high levels of EE CRIT had significantly more behavioral problems than children of mothers showing less criticism (Withdrawn: F = 5.44, p = 0.24, d = 0.78; Anxious/Depressed: F = 13.61, p = 0.001, d = 1.23; Social problems: F = 17.43, p = 0.001, d = 1.39; Attention problems: F = 6.10, p = 0.017, d = 0.08; Rule-breaking behavior: F = 7.20, p = 0.010, d = 0.89; Aggressive

behavior: F = 9.04, p = 0.004, d = 1; Internalizing problems: F = 12.13, p = 0.001, d = 1.16; Externalizing problems: F = 8.23, p = 0.006, d = 0.95; Global strain: F = 12.95, p = 0.001, d = 1.19) (see Fig. 2).

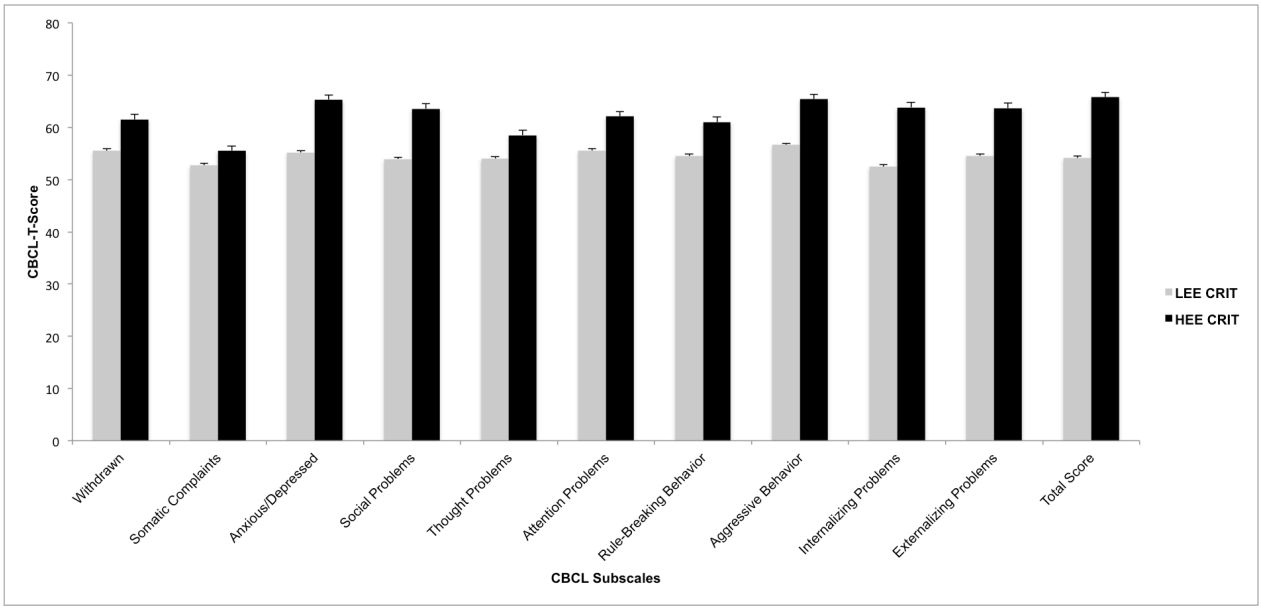

Figure 2. Association between maternal expressed emotion criticism and internalizing and externalizing problems of the child.

When controlling for maternal psychopathology by using the global severity index of BSI (GSI) as a covariate, the difference in child behavioral and emotional problems (total CBCL score) between those with mothers with high compared to low EE CRIT was still significant (F = 4.48, p = 0.04, d = 3.7).

Association between maternal expressed emotion criticism and maternal psychiatric symptoms

Except for the subscales somatization and phobia, all subscales differed significantly in low and high EE CRIT rates. Mothers with high EE CRIT showed significantly more mental health problems in the GSI compared to mothers expressing low rates of EE CRIT (Obsessive-compulsive: F = 8.70, p = 0.005, d = 1.13; Interpersonal sensitivity: F = 13.31, p = 0.001, d = 1.35; Depression: F = 10.85, p = 0.002, d = 1.33; Anxiety: F = 8.01, p = 0.007, d = 1.12; Hostility: F = 11.39, p = 0.001, d = 1.15; Paranoia: F = 13.16, p = 0.001, d = 1.25; Psychoticism: F = 8.99, p= 0.004, d = 0.91; Global severity index: F = 12.70, p =. 0001, d = 1.61) (see Fig. 3).

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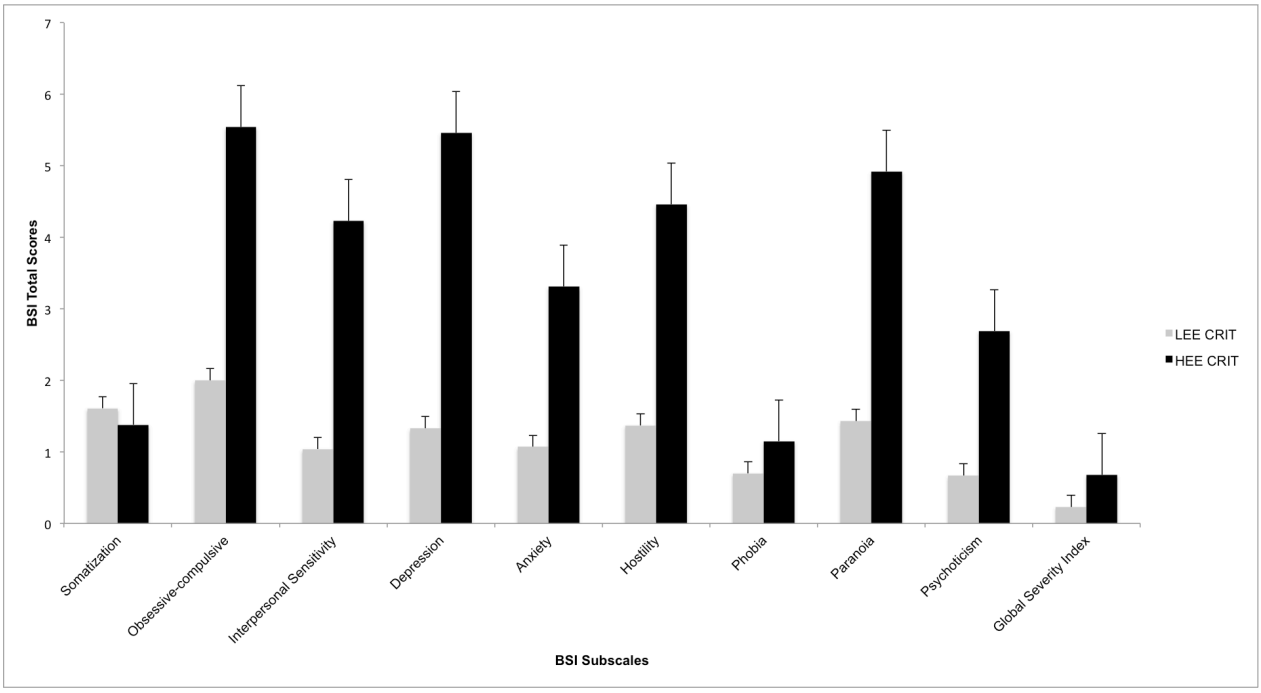
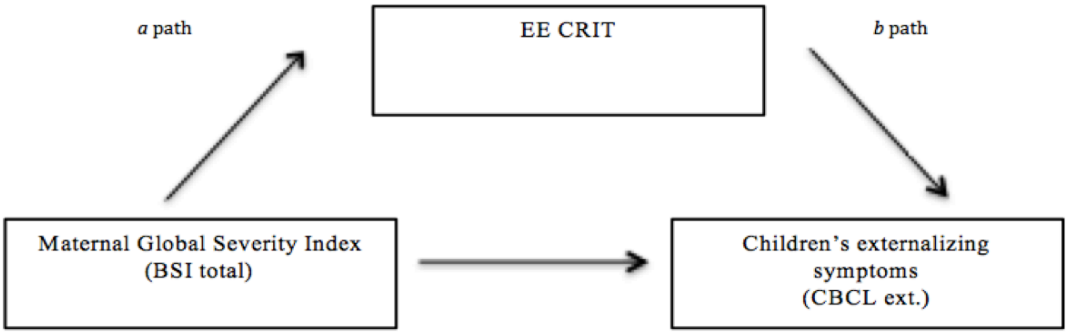


Figure 3. Association between maternal expressed emotion criticism and maternal psychiatric symptoms.

Mediating effect

Results of the linear regression analyses revealed that children of mothers who scored higher on the GSI had a significantly higher probability of being classified as having clinically relevant externalizing behavioral problems (corrected $R^2 = 0.112$, $F = 7.04$, $\beta = 0.361$, $p = 0.011$, $d = 0.54$). The direct effect of this association decreased to a statistically non-significant level ($\beta = 0.218$, $p = 0.147$) while accounting for EE CRIT as a mediator (corrected $R^2 = 0.171$, $F = 5.96$, $\beta = 0.310$, $p = 0.04$, $d = 0.50$) (see Fig. 4).



c path

β = .361 (P = .011)

c' path

β = .218 (P = .147)

Total model R^2 = .21, F (2, 46) = 6.13, p< .001

Figure 4. Mediating effect.

Discussion

Our first study goal was to investigate whether in mothers expressing high expressed emotion criticism (EE CRIT) the mother-child interaction is negatively affected. Our data partially supported our first hypothesis, as high rates of EE CRIT were associated with more negative mother-child interactional patterns. We found that high maternal EE CRIT is related to less responsive children, indicating that these children show less willingness to touch upon communication signals sent by their mothers. This is consistent with the finding of McCarty, Lau, Valeri, and Weisz (2004). In addition, overall maternal harmony and warmth was significantly lower during mother-child interactions when the mother belonged to the high EE CRIT group. Moreover, we found a trend that high rates of maternal EE CRIT have a negative effect on mothers' sensitivity towards their children. We could not find any differences between low/high maternal EE CRIT on maternal structuring behavior or intrusiveness.

Second, we investigated whether higher rates of expressed criticism in mothers are associated with both higher rates of internalizing and externalizing child mental problems. Our second hypothesis was also supported.

Children with elevated internalizing and externalizing symptoms had mothers who expressed significantly more criticism towards them. These associations are consistent with the literature on the subject (Baker et al., 2000; Caspi et al., 2004; Denise Renee Nelson, 2001; Psychogiou et al., 2007), and remained significant after controlling for maternal metal problems.

Additionally, we investigated whether higher rates of expressed criticism in mothers are associated with higher rates of mental problems in mothers. Our third hypothesis could also be supported by our data, as mothers with elevated psychiatric symptoms expressed significantly more criticism towards their children. Most studies examining the influence of maternal depression on EE found that high levels of maternal depression predicted high EE ratings (Denise R Nelson et al., 2003; Tompson et al., 2010). In our study, we assessed a whole range of maternal psychiatric symptoms, including symptoms of depression. Except for two subscales, all other maternal psychiatric symptoms (psychoticism, paranoia, hostility, anxiety, interpersonal sensitivity, obsessive-compulsive behavior, and psychiatric global strain) had as much influence on EE CRIT as depression symptoms did and showed large effect sizes.

Finally, our hypothesis that the association between maternal and children's mental health problems is mediated by EE CRIT was supported only for externalizing problems, not for internalizing ones. This result is consistent with a previous finding of Denise R Nelson et al. (2003). Thus, our results also indicate that EE CRIT is more important when it comes to the extent to which children exhibit under-controlled, impulsive, rule-breaking and aggressive behavior than it is regarding internalizing problem behavior. As there is convincing evidence that a harsh and negative parenting style is a risk factor for externalizing problem behavior in children, e.g. conduct disorder (Denham et al., 2000), our results indicate that even already parental expressed emotion criticism might be considered as a risk factor for the development of externalizing behavior disorders. One possible explanation might be that the development of social norms, prosocial behavior and impulse/behavioral control in children is presumed to rather develop in social contexts of emotional learning in daily interactions. The development of internalizing symptoms might have other roots, e.g. temperamental factors as behavioral inhibition and anxious models have been discussed as main risk factors (Fisak & Grills-Taquechel, 2007).

Conclusions

Some study limitations merit acknowledgement. First, the relatively small sample size limited our ability to test some more complex associations or subgroup comparisons. Replications with larger sample sizes are strongly recommended. However, as we included children's responsiveness in an objective observational task and found significant associations with maternal EE CRIT, we can refute an exclusive maternal bias.

Nevertheless, future studies are strongly encouraged to incorporate multiple measures of child psychopathology symptoms in order to clarify the question on reports by mothers. Prospective longitudinal studies of larger numbers of children will be needed to confirm these conclusions and clarify a possible causal direction of effects.

Despite the limitations, study strengths should get some acknowledgment too. First, our findings provide new knowledge about direct associations between EE and mother-child interactional patterns using a structured and objective instrument to measure quality of mother-child-interaction. Second, we did not only focus on maternal depression only but included a broad spectrum of maternal symptoms of psychopathology indicating that other mental health problems have similar associations with EE than depressions does.

Finally, the findings of the study have important implications for interventions and clinical practice. Criticism should be a target of interventions, as highly critical mothers might engage in negative interactions with their child, thus contributing to the escalation of negative mother-child interactions. In this regard, results provide important knowledge regarding possible starting points for more tailored intervention programs focusing on mother-child interaction.

Acknowledgments

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Chapter 4 Psychophysiological Responses to Emotion Induction through Film Clips in Girls and Boys with Conduct Disorder

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Purpose

Reduced psychophysiological responses during emotion processing have been reported in boys with Conduct Disorder (CD). However, little is known regarding the mechanisms underlying CD in girls. Therefore, this study investigated psychophysiological reactivity during emotion induction in a large sample of CD girls and boys in comparison to controls. Furthermore, we examined CD with Limited Prosocial Emotions (LPE) and/or comorbid internalizing disorders (INT) to assess its association with physiological hypo- and hyper-reactivity, respectively.

Methods

927 girls (427 CD, 500 controls) and 519 boys (266 CD, 253 controls) aged 9-18 years participated in a multi-site European study. Two validated sad film clips were presented while measuring psychophysiological activity by Heart Rate (HR), Respiratory Sinus Arrhythmia (RSA; parasympathetic activity), and Pre-Ejection Period (PEP; sympathetic activity).

Results

Both CD girls and boys showed a significantly larger HR decrease while viewing sad film clips than controls. However, this effect was no longer significant after controlling for smoking. The RSA and PEP responses did not differ between the groups. There were no differences in physiological reactivity between those with versus without INT, whereas CD individuals without LPE demonstrated a larger increase in HR and RSA. Results were similar in both sexes.

Conclusions

This study showed that CD girls and boys are characterized by physiological hyper-reactivity to sadness, which is most pronounced in CD without LPE. These findings corroborate previous research suggesting emotion regulation problems in CD. Furthermore, we recommend that future studies assess smoking to unravel its influence on psychophysiological reactivity.

Key words: conduct disorder, psychophysiology, emotion processing, girls

Introduction

Conduct Disorder (CD) is characterized by a persistent pattern of rule-breaking, aggressive and antisocial behavior, with severe negative consequences for both the affected individual as well as his or her family members and peers (American Psychiatric Association, 2013). Prevalence estimates indicate that CD is more common in boys than in girls, with sex ratios ranging from 1.4:1 up to 10:1 (Moffitt, Caspi et al. 2001, Merikangas, He et al. 2010). Despite the lower prevalence rate, the negative outcomes of CD in girls are substantial. Girls with CD face an increased risk of financial problems, substance abuse, mental and physical health problems, prostitution and teenage pregnancy, resulting in major societal costs (Odgers, Moffitt et al. 2008, Rivenbark, Odgers et al. 2018). There is increasing evidence that CD may have a neurobiological basis (Blair, Leibenluft et al. 2014, Freitag, Konrad et al. 2018). The vast majority of studies have focused on boys and therefore we know little about the neurobiological mechanisms underlying CD in girls. Furthermore, it is unknown whether existing findings in boys can be generalized to girls. Neuroimaging studies (Zhang, Gao et al. 2014, Smaragdi, Cornwell et al. 2017), psychophysiological studies (Beauchaine, Hong et al. 2008, Crozier, Dodge et al. 2008, Zhang, Fagan et al. 2017, Beauchaine, Bell et al. 2019), and a genome-wide study (Tielbeek, Johansson et al. 2017) demonstrated that neurobiological deficits were different for girls and boys with antisocial behavior. Other studies, however, did not find sex differences in neurobiological measures of CD (Fairchild, Van Goozen et al. 2008, Fairchild, Stobbe et al. 2010, Oldenhof, Prätzlich et al. 2018). To increase the knowledge of the neurobiological basis of female CD and to study sex differences in CD, we investigated the physiological correlates of emotion processing in girls and boys with CD in a large European multicenter study (FemNAT-CD).

There is considerable evidence for deficits in the neurobiological underpinnings of emotion processing in CD. For instance, reduced physiological reactivity to emotional stimuli (e.g. lower change in heart rate; (Herpertz, Mueller et al. 2005, De Wied, Boxtel et al. 2009, Fairchild, Stobbe et al. 2010, de Wied, van Boxtel et al. 2012). Physiological responses are generated by the Autonomic Nervous System (ANS) in response to external stimuli to produce adaptive behavior (Yang, Simmons et al. 2007, Matthys, Vanderschuren et al. 2013). Sad stimuli, for example, elicit a decrease in heart rate (HR) to promote a *conservation withdrawal response*

(Kreibig, Wilhelm et al. 2007, Kreibig 2010). Physiological hypo-reactivity in CD is suggested to reflect interfered emotion processing, thereby explaining emotional and behavioral problems in CD. However, also physiological hyper-reactivity has been found in CD, as well as null findings (Fanti 2018, Fanti, Eisenbarth et al. 2019).

These inconsistent findings may be explained as a result of heterogeneity between study samples as well as within study samples, and methodological differences.

First, both clinical and community samples have been used to study antisocial behavior. Clinical samples are typically more extreme and have higher levels of comorbidity than community sample, and categorical approaches are often used in the former but dimensional approaches in the latter. Furthermore, Beauchaine (2009, 2015) and others have suggested that the association between ANS functioning and antisocial behavior may differ with different degrees of antisocial behavior. The majority of studies have used community samples, and it is questioned whether these results apply to clinical samples. A recent meta-analysis, however, demonstrated that the association between ANS responding and antisocial behavior was similar for clinical and non-clinical samples (Fanti, Eisenbarth et al. 2019). Therefore, to clarify emotion processing in CD we have investigated a large sample of clinically diagnosed girls and boys.

Second, heterogeneity within clinical samples may lead to inconsistent research findings (Fanti 2018). DSM-5 specifies a subtype of CD with Limited Prosocial Emotions (LPE), referring to an uncaring and unemotional interpersonal style, and showing deficits in guilt and empathy (APA, 2013). CD with LPE (hereafter CD+LPE) is associated with reduced ANS responses to emotions (hypo-reactivity) as compared to CD without LPE (Anastassiou-Hadjicharalambous and Warden 2008, de Wied, van Boxtel et al. 2012, Musser, Galloway-Long et al. 2013). In contrast, hyper-reactivity (i.e. increased ANS responses) has been found in individuals presenting with both externalizing (e.g. CD) and internalizing (e.g. depression, anxiety) problems (Calkins, Graziano et al. 2007, Pang and Beauchaine 2013, Deutz, Woltering et al. 2018). This combination seems more prevalent in girls than in boys (Lehto-Salo, Närhi et al. 2009). In a previous study we demonstrated that girls with CD and comorbid internalizing disorders presented with specific ANS deficits during a baseline assessment (Oldenhof, Prätzlich et al. 2018). As this study focuses on CD in girls, it is important to investigate

the combination of CD with internalizing problems. Furthermore, recent work has suggested that the LPE and internalizing disorders are not mutually exclusive. Some individuals of the CD+LPE subtype also present with anxiety, which was more prevalent in girls than in boys (Cecil, McCrory et al. 2018). Combined LPE and internalizing disorders (CD+LPE+INT) seems characterized by increased ANS responses as compared to LPE without internalizing disorders (CD+LPE-INT; (Kimonis, Skeem et al. 2011, Kahn, Frick et al. 2013, Fanti 2018). Taking account of heterogeneity in CD might thus clarify inconsistencies in the literature. Therefore, this study will consider CD with/without *Limited Prosocial Emotions* (CD+/-LPE), CD with/without comorbid internalizing disorders (CD+/-INT), and CD with LPE and with/without co-occurring internalizing disorders (CD+LPE+/-INT).

Third, methodological variations may underlie inconsistencies in the field. Physiological indices of emotion processing should be measured during a standardized emotion evocative procedure, relative to a standardized resting period. Many studies, however, make inferences about emotion processing based on the use of non-emotional stimuli. Beauchaine (2015) described that emotion evocation is associated with excessive responses of the parasympathetic nervous system (PNS) in antisocial individuals, whereas attention demanding and executive function tasks are associated with a diminished response of the PNS in antisocial populations. Furthermore, there is evidence that emotion processing deficits vary for different emotions (Fairchild, Van Goozen et al. 2009, Gatzke-Kopp, Greenberg et al. 2015). This might explain inconsistent findings between studies using stimuli of different emotional valence. However, a recent study found similar deficits in emotion processing in CD across six different emotions (Kohls, Baumann et al. 2019). Finally, many studies use static emotional pictures, while film clips may be more ecologically valid (Gross and Levenson 1995). Therefore, in this study, we have used two validated film clips that induce acute sadness to investigate the psychophysiological correlates of emotion processing.

Lastly, whereas heart rate (HR) is the most frequently used physiological response measure, using alternative measure can help to identify individual differences in physiological emotion processing. HR is a product of the antagonistic effects of the parasympathetic and sympathetic nervous system (PNS and SNS). The PNS promotes resting and digesting, resulting in a decrease in heart rate. In contrast, the SNS enhances behavioral

activation, such as fight/flight responses, resulting in an increase in heart rate. The SNS and PNS constantly interact to enable optimal physiological functioning to meet both internal (homeostasis) and external (environmental stimuli) demands (Appelhans and Luecken 2006). Incorporating PNS and SNS measures might thus enhance the understanding of physiological emotion processing. PNS activity has been studied extensively in relation to emotion processing through heart rate variability (HRV). CD and related conditions are associated with reduced baseline HRV (Beauchaine and Thayer 2015). Its association with HRV reactivity to emotional stimuli is still unclear, however. Two recent meta-analyses reported conflicting results: Beauchaine and colleagues (2019) demonstrated that CD and other externalizing disorders are associated with increased HRV reactivity, whereas Fanti and colleagues (2019) found no association. SNS reactivity has been studied less frequently in relation to emotional stimuli. Previous studies have associated decreased electrodermal responses, a marker of SNS activity, to fearlessness, which in turn, is highly associated with CD (Lorber 2004, Fanti 2018). Cardiac SNS activity is measured by Pre-ejection Period (PEP) and has been associated with reward sensitivity (Brenner and Beauchaine 2011). Whether PEP also reflects emotion processing is still unclear. To explore if and how PNS and SNS activity are associated with emotion processing in CD, we have included HRV and PEP measures in this study.

The aim of this study was to investigate the psychophysiological underpinnings of emotion processing in girls with CD and investigate sex differences in psychophysiological reactivity in CD. Therefore, we assessed ANS responses to emotion induction and

1) compared a clinical sample of CD children and adolescents with their typically- developing peers.
2) conducted group-by-sex interactions to investigate sex differences
3) investigated the impact of CD subtype: CD with Limited Prosocial Emotions (CD+/-LPE), CD with internalizing comorbidity (CD+/-INT), and CD with co-occurring LPE and internalizing disorder (CD+LPE+INT).

We hypothesized finding decreased HR reactivity, but increased HRV (PNS) reactivity to emotion induction in CD girls and boys as compared to their typically developing peers. We expected to find a sex-by-group

interaction, with CD girls presenting stronger HR and HRV reactivity than CD boys, given increased rates of internalizing problems in CD girls. Since studies on PEP and emotional processing are sparse, PEP reactivity to emotion induction was analyzed exploratively in this study. We expected CD with Limited Prosocial Emotions (CD+LPE) to show diminished HR and HRV reactivity as compared to CD-LPE and controls. In contrast, we expected increased HR and HRV reactivity in CD with internalizing comorbidity (CD+INT) as compared to CD-INT and controls. Lastly, individuals with CD+LPE+INT were expected to show increased HR and HRV reactivity as compared to CD+LPE-INT.

Method

This study is part of the multicenter European FP7 study **FemNAT-CD**: Neurobiology and Treatment of Adolescent Female Conduct Disorder: The Central Role of Emotion Processing (for a description see (Freitag, Konrad et al. 2018)). It was approved by the European Commission and the local ethical committees of all participating sites. The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants and their caregivers.

Participants

This study included 1446 children and adolescents: 927 females (427 cases and 500 typically developing controls) and 519 males (266 cases and 253 controls) aged 9-18 years (mean = 14.22, SD = 2.4). Individuals were classified as cases if they met diagnostic criteria for CD, assessed with the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL; (Kaufman, Birmaher et al. 1997)). Individuals aged 9-12 years were also classified as cases when they met full diagnostic criteria for Oppositional Defiant Disorder (ODD) and had at least 1 CD symptom. Individuals aged 13+ years were classified as cases when they met full diagnostic criteria for ODD and had at least 2 CD symptoms. Participants were classified as controls if they were free of current psychiatric disorders (besides learning disorders such as dyslexia), and were free of CD, ODD, and Attention-Deficit/Hyperactivity Disorder (ADHD) in the past. Exclusion criteria for both controls and cases were: ICD-10, DSM-IV TR or DSM-5 clinical diagnosis of autism spectrum disorder or schizophrenia currently or in the past, current bipolar disorder or mania, known monogenetic disorder, genetic syndrome, any chronic or acute neurological disorder (e.g.

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cerebral palsy), current treatment for epilepsy, history of moderate to severe traumatic brain injury, and an IQ below 70. Table 1 shows characteristics of the sample.

Participants were recruited by distributing study flyers, and advertising in internet forums, and through schools, clinics and youth welfare institutions in seven countries (England, Germany, Greece, Hungary, Netherlands, Spain, Switzerland).

Table 1

Demographic and clinical characteristics of the sample

	GIRLS		BOYS		
	CD (N=427)	CONTROL (N=500)	CD (N=266)	CONTROL (N=253)	
	M *(SD)*	*M* *(SD)*	*M* *(SD)*	*M* *(SD)*	Statistical comparisons
Age	14.74 (2.02)	14.19 (2.44)	13.82 (2.56)	14.04 (2.55)	$F=9.64$, $p < .001$ [a,b]
Medication *	133/424 (31.4%)	17/495 (3.4%)	89/261 (34.1%)	7/253 (2.8%)	$\chi^2=215.30$, $p < .001$ [a,c]
Sports (h/wk)	2.84 (3.33)	3.91 (3.66)	5.55 (5.78)	5.77 (5.06)	$F=29.27$, $p < .001$ [a,b,d]
Smoker	250/413 (60.5%)	18/478 (3.8%)	88/227 (38.8%)	21/226 (9.3%)	$\chi^2=407.91$, $p < .001$ [a,b,c,d]
Cigarettes per day **	9.67 (6.91)	8.50 (7.49)	11.26 (7.89)	6.05 (4.30)	

BMI	22.53 (4.55)	20.85 (4.25)	21.23 (4.25)	20.57 (4.07)	F=13.70, $p < .001$ [a,b]
Internalizing disorder (INT)	152/406 (37.4%)	0	63/258 (24.4%)	0	χ^2=12.21, $p < .001$ [b]
LPE specifier	163/421 (38.7%)	73/499 (14.6%)	132/266 (49.6%)	63/253 (24.9%)	χ^2=123.40, $p < .001$ [a,b,c,d]
LPE + INT	52/153 (34.0%)	0	30/129 (23.3%)	0	χ^2=3.41, $p = .065$ [b]

Note: * Only medications with potential effects on heart activity was recorded; ** Only smokers were included in the computation of mean number of cigarettes smoked/day; Internalizing disorder = any internalizing disorder such as a mood disorder, post-traumatic stress disorder, or anxiety disorder; LPE = Limited Prosocial Emotions; BMI = Body Mass Index.

[a] = female CD versus female control

[b] = female CD versus male CD

[c] = male CD versus male control

[d] = female control versus male control

Clinical assessment

Psychiatric Diagnosis. Diagnostic information was obtained using the K-SADS-PL (Kaufman, Birmaher et al. 1997), a standardized, semi-structured clinical interview assessing current and past episodes of psychopathology according to DSM-5 criteria. Interviews were conducted with the participant and a parent or caretaker. Additionally, where available, information from medical or case files was used. Summary ratings were derived from the clinical judgment using all sources. Internalizing psychopathology was defined as meeting the DSM-5 criteria for any of the following mood or anxiety disorders: depression, adjustment disorder, disruptive mood dysregulation disorder (DMDD), anxiety disorder, obsessive compulsive disorder (OCD), post-traumatic stress disorder (PTSD).

Limited Prosocial Emotions (LPE). We used the Youth Psychopathic traits Inventory (YPI; (Andershed, Kerr et al. 2002)) to assess LPE, according to Collins and Vermeiren (2013). This method appeared effective in identifying CD girls (Colins and Andershed 2015, Jambroes, Jansen et al. 2016) and boys (Jambroes, Jansen et al.) who showed higher levels of aggressiveness, delinquency, and rule breaking behavior. The YPI consists of 50 items with a 4-point Likert scale, ranging from "Does not apply at all" (1) to "Applies very well" (4). This study used the three subscales of the dimension Callous Unemotionality: unemotionality, callousness and remorselessness. Each subscale consists of five items. A participant met criteria for one of the CU traits when she/he reported that at least one item on the corresponding subscale "applied very well". Participants were considered to meet LPE when they met criteria for at least two CU traits.

Defining CD subtypes. The CD subtype with Limited Prosocial Emotions (CD+LPE) was defined as CD participants who met criteria for at least two CU traits measured via the YPI. The CD subtype with internalizing comorbidity (CD+INT) was defined as CD participants currently meeting criteria for at least one internalizing disorder, or at least one of these disorders being in partial remission, assessed via the K-SADS. Lastly, a subtype of CD with both LPE and internalizing comorbidity (CD+LPE+INT) was identified as CD participants fulfilling the criteria for LPE, and meeting criteria for an internalizing disorder, either currently or in partial remission.

Emotion Processing. Emotion processing was indexed by the physiological response during an emotion induction task. Two validated film clips that evoke acute sadness were presented (Gross and Levenson 1995, de Wied, Goudena et al. 2005). Film clips inducing acute sadness have been shown to elicit a consistent physiological response: a decrease in HR, an increase in PNS activity (higher RSA), and a decrease in SNS activity (longer PEP) (for a review see (Kreibig 2010)). An excerpt (93 sec) from *The Champ* (Lovell & Zeffirelli, 1979) and an excerpt (164 sec) from *The Bear* (Annaud & Berri, 1988) were presented. The scene in which the emotion sadness was most intensely displayed was identified as the 'target scene'. For both film clips this was the last scene: the last 41 seconds of the excerpt from *The Champ*, and the last 42 seconds of the excerpt from *The Bear*. The order in which the film clips were presented to the participant was counterbalanced. Each film clip was preceded by a one-minute relaxation video (Coral Sea Dreaming, Small

World Music Inc.). The emotion evocation task was presented on a DELL Latitude E5550 Laptop with Sennheiser HD 201 earphones.

The physiological response (Δ) was defined as: 'target scene' – 'preceding relaxation video'. As such, negative values represent a decrease in ANS activity during the emotional film clip, whereas positive values indicate an increase in ANS activity.

Autonomic Nervous System (ANS) assessment. ANS activity was assessed during the emotion evocation task to measure the physiological response to emotions. Heart Rate (HR) in beats per minute (bpm) was derived from the ECG signal derived R-peak time series. To obtain a measure of Parasympathetic Nervous System (PNS) activity, Heart Rate Variability (HRV) was assessed. This was operationalized by Respiratory Sinus Arrhythmia (RSA), i.e. the high-frequency component of HRV. Respiratory Sinus Arrhythmia (RSA) is defined as the longest period between two successive heart beats during expiration minus the shortest period during inspiration and is thought to be a reliable indicator for PNS activity (Grossman and Taylor 2007, Thayer, Åhs et al. 2012). Higher RSA values indicate higher HRV, reflecting greater PNS activity. RSA was computed on a breath-to-breath basis. When no difference in shortest and longest beats could be detected, RSA was set to be zero for that particular breath. RSA values were set as missing when more than 50% of the breaths could not be detected or were identified as 'irregular' by the VU-DAMS software. Sympathetic Nervous System (SNS) activity was measured by the Pre-Ejection Period (PEP; expressed in ms). This is currently the most reliable non-invasive indicator of SNS activity and can be derived from combined ICG and ECG recording (van Lien, Schutte et al. 2013). PEP is defined as the time period between the onset of the left ventricular depolarization and the opening of the aortic valve. These events are marked respectively by the Q-wave onset in the ECG and the B-point in the ICG. Longer PEP indicates lower SNS activity.

The VU-AMS device (Vrije Universiteit Ambulatory Monitoring System; (de Geus, Willemsen et al. 1995) was used for ECG and ICG registration. H98SG, ECG Micropore electrodes were used and the skin was cleaned with alcohol before electrode application. The R-peak time series was derived from the ECG data by an automated detection algorithm within the VU-DAMS software package version 3.9 and was checked manually

for missed or incorrect R-wave peaks and abnormalities in the registration. Abnormalities were defined as Premature Ventricular Contractions (PVCs) and Premature Atrial Contractions (PACs) or low-quality ECG signal fragments, and were removed from the data. Ensemble averaged ECG and ICG complexes were derived from all valid heartbeats. In the ensemble averaged ECG the Q-onset was detected, and in the ensemble averaged ICG the B-point, dZ/dt-min peaks and X-points were identified by an algorithm within the VU-AMS software package. All scoring in the ensemble averaged complexes was again checked manually. Data on Respiration Rate was derived from the dZ-signal (thorax impedance). The VU-DAMS software identified 'irregular respiration' when deviations in the duration of consecutive breaths reach a threshold. When more than 50% of the respiration data was identified as 'irregular' RSA data was set as missing. Data checking and scoring was performed by trained researchers and students, and consensus meetings were organized for complex data.

Procedure physiological assessment. Prior to the physiological assessment, participants were asked whether they had smoked in the past hour, consumed alcohol or used drugs in the past 24 hours. If they answered affirmatively to any of these questions, the assessment was postponed. Otherwise, ECG/ICG electrodes were applied to the participant's body. The assessment started with a 10-minute habituation period to minimize the effect of stress induced by the experimental setting. The emotion induction task was part of a larger physiological assessment. Tasks were separated by relaxation videos to minimize carryover effects.

Data processing

Physiological data on *The Champ* clip was not available for 15 participants and data on the *The Bear* clip was not available for 8 participants. This was either due to technical problems or interruption of the assessment. Values were set to missing when visual inspection identified bad signal quality (for instance >50% irregular respiration for RSA). This resulted in 4 missing values for ΔHR, 37 for ΔRSA, and 141 for ΔPEP during *The Champ* clip, and 1 missing value for ΔHR, 53 for ΔRSA, and 125 for ΔPEP during *The Bear* clip. Values +/- 3SD were identified as outliers and excluded from the analysis. This resulted in 14 outliers for ΔHR, 25 for

ΔRSA, and 11 for ΔPEP during *The Champ* clip, and 16 outliers for ΔHR, 28 for ΔRSA, and 11 for ΔPEP during *The Bear* clip.

For descriptive purposes the average value of each of the psychophysiological measures during the target scenes of the sad film clips and during the preceding relaxation videos is presented in Appendix A (see supplementary material). Outliers were excluded following the same procedure as described above.

Statistical analyses and covariates.

An ANCOVA was run to investigate the main effect of group (CD vs control), and a group*sex interaction on the physiological response during emotion induction. An ANCOVA was run for each physiological measure (HR, RSA, PEP), and for each film clip separately. We controlled for the baseline value of the physiological measure, as the baseline value could potentially affect the magnitude of the response. The ANCOVA was repeated when covariates were identified for a physiological response measure. Covariates were selected when they showed a significant correlation with the physiological response measure (see Appendix B, supplementary material). For film clip *The Champ,* smoking (cigarettes/day) was identified as a covariate for ΔHR, and BMI a covariate for ΔRSA. There were no covariates detected for ΔPEP. For film clip *The Bear,* age and smoking were identified as covariates for ΔHR, age was a covariate for ΔPEP, and no covariates for ΔRSA.

All tests were two-tailed and Bonferroni correction was applied for post-hoc analyses.

Results

To validate the task, we ran paired sample T-tests to compare psychophysiological activity during baseline and during the target scene (see appendix A). There was a significant decrease in HR from baseline (M= 79.62, SD=11.18) to the target scene (M= 75.84, SD=11.31) during *The Champ* (t = 30.544, p < .001). Similar effects were observed for the *Bear*: HR decreased from baseline (M= 79.30, SD=11.31), to the target scene (M= 74.78, SD=11.39) (t = 34.183, p < .001). During *The Champ* there was no significant change in RSA activity, whereas PEP increased significantly (baseline: M= 100.56, SD=18.55, target scene: M= 101.59, SD=18.94; t = -8.569, p < .001). For the *Bear* we found the inverse pattern: RSA increased significantly (baseline: M= 82.14, SD=43.15, target scene: M= 86.95, SD=45.83; t = -5.479, p < .001), whereas PEP activity did not change.

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Main effect of CD and Sex differences in the relationship between CD and physiological responses during emotion evocation

Table 2 presents descriptive and inferential statistics for each physiological measure in CD and control girls and boys for both film clips.

Table 2

Physiological response during the emotion evocation task in the CD and control groups

	GIRLS		BOYS		Statistical comparisons	
	CD (N=420)	CONTROL (N=492)	CD (N=261)	CONTROL (N=250)	Group	Group x Sex
	M *(SD)*	*M* *(SD)*	*M* *(SD)*	*M* *(SD)*	F	F
ANS responses during The Champ film clip						
ΔHR (bpm)	-3.65 (4.35)	-3.18 (4.09)	-4.80 (4.70)	-4.00 (4.33)	4.81*	.17
ΔRSA (msec)	1.62 (29.43)	-1.22 (28.51)	-.26 (31.41)	-2.22 (28.31)	1.89	.10
ΔPEP (msec)	0.78 (3.73)	1.13 (3.75)	1.18 (4.24)	1.26 (4.49)	.62	.29
ANS response during Bear film clip						
ΔHR (bpm)	-4.83 (4.70)	-3.98 (4.47)	-4.98 (4.79)	-4.57 (4.73)	4.47*	1.54
ΔRSA (msec)	5.01 (29.13)	2.89 (29.70)	7.86 (29.72)	2.31 (31.23)	3.52	1.34
ΔPEP (msec)	-.03 (4.32)	-.41 (4.09)	.29 (4.52)	-.14 (4.61)	2.84	.01

Note: HR = heart rate, RSA = respiratory sinus arrhythmia, PEP = pre-ejection period

* $p < 0.05$

Film clip The Champ. There was a statistically significant effect of group for the HR response to the *Champ* ($F(1,1398)=4.81$ $p=0.028$, $n_p^2=0.003$), with CD cases showing a larger decrease in heart rate than controls (see Figure 2). The group*sex interaction effect was not significant (p=.681). For both the PEP and the RSA response, there were no significant main effects of group, nor was there a significant group*sex interaction effect. The ANCOVA on the HR response was repeated with smoking added as a covariate. The group effect was abolished ($F(1,1299)=0.22$, $p=0.642$, $n_p^2=0.000$). The ANCOVA on the RSA response was repeated with BMI added as a covariate. Results remained unchanged.

Film clip The Bear. We found a statistically significant effect of group for the HR response from baseline to the target scene of the *Bear* ($F(1,1406)=4.47$, $p=0.035$, $n_p^2=0.003$), with CD girls and boys showing a larger decrease in heart rate than controls (see Figure 3). The group*sex interaction effect was not significant (p=.215). For the RSA response, a trend toward significance emerged for the main effect of group ($F(1,1337)=3.52$, $p=0.061$, $n_p^2=0.003$). CD girls and boys showed a tendency towards a larger increase in RSA than controls, indicating a larger increase in parasympathetic nervous system activity. This effect was similar for boys and girls (no group*sex interaction effect). There was no significant main effect for group, nor a group*sex interaction effect for the PEP response. The analyses on the HR response were repeated after including age and smoking as covariates. The main effect of group reduced to the level of a trend after age was included ($F(1,1405)=3.39$, $p=0.066$), and was rendered non-significant when smoking was added ($F(1,1306)=0.26$, $p=0.607$). The analyses on the PEP response were repeated after including age as a covariate. The results remained unchanged.

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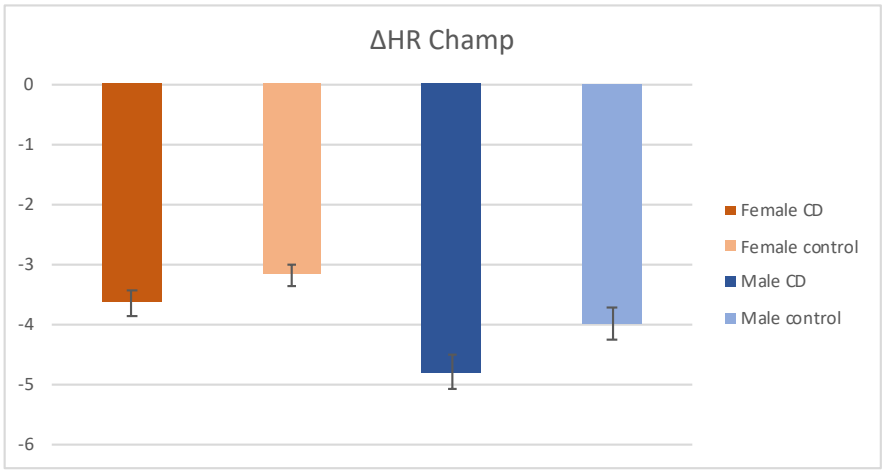

Figure 1. Heart Rate (HR) change during The Champ film clip.
Error bars represent SE.

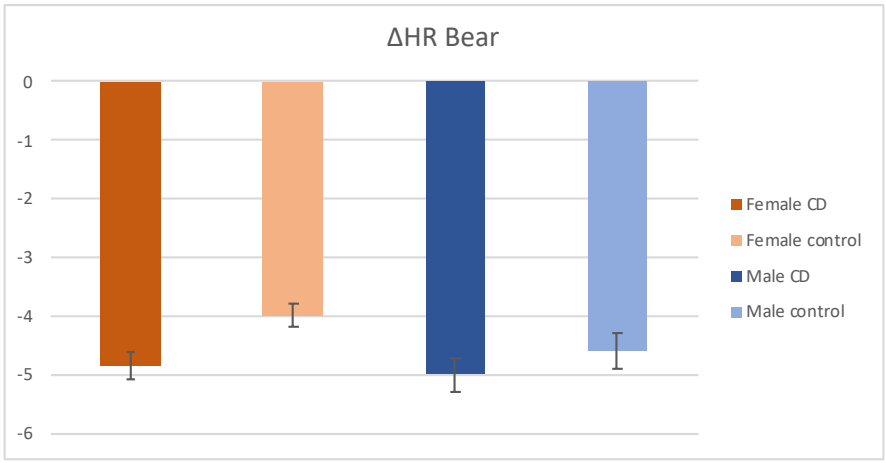

Figure 2. Heart Rate (HR) change during the Bear film clip.
Error bars represent SE.

In sum, we found a significantly larger decrease in heart rate during both sadness-inducing film clips in the CD group as compared to controls. After correcting for smoking, however, the effect of group on HR response became non-significant (see Step 1, 2 in Table 3). The uneven distribution of smokers among the groups (49.7% smokers in CD versus 6.6% in the controls) shows that smoking strongly associates with group, and thus may not be an independent covariate. Therefore, to further investigate whether the differences in HR reactivity between CD and controls differed between smokers and non-smokers, an additional regression analysis was performed with group, smoking (coded dichotomously) and their interaction as predictors. The

analysis showed that differences between CD and controls in HR reactivity were not different for smokers compared to non-smokers for both film clips (Step 3 in Table 3).

Table 3

Standardized regression coefficients (β) of group and smoking on the HR response

	Δ HR *The Champ*	Δ HR *Bear*
Step 1		
Group	-0.060 (p=0.03)	-0.056 (p=0.04)
Step 2		
Group	-0.048 (p=0.14)	-0.022 (p=0.50)
Smoking	-0.022 (p=0.49)	-0.066 (p=0.04)
Step 3		
Group	-0.051 (p=0.14)	-0.013 (p=0.70)
Smoking	-0.039 (p=0.60)	-0.022 (p=0.77)
Group*Smoking	0.020 (p=0.80)	-0.051 (p=0.52)

Note: Group is coded: 0=control 1=case; Smoking is coded: 0=non-smoker 1=smoker

Effects of CD subtypes on physiological responses during emotion evocation

First, we investigated the CD subtype with Limited Prosocial Emotions. We used an ANCOVA investigating the main effect of group (CD+LPE, CD-LPE, control), and the group*sex interaction effect.

For *The Champ* we found a trend toward significance for the main effect of group on the HR response ($F(2,1390)=2.84$, $p=0.059$, $n_p^2=0.004$). In contrast with our expectations, we did not find impaired physiological responses in CD+LPE, but we found a significantly larger HR decrease in CD-LPE as compared to controls (p=0.055; see Figure 4). There was no group*sex interaction effect. For both the PEP and the RSA responses the main effects of group, and group*sex interaction effects were not significant. Smoking was added

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as a covariate to the ANCOVA on the HR response, which rendered the main effect for group non-significant ($F(2,1291)=0.28$, $p=0.758$, $n_p^2=0.000$).

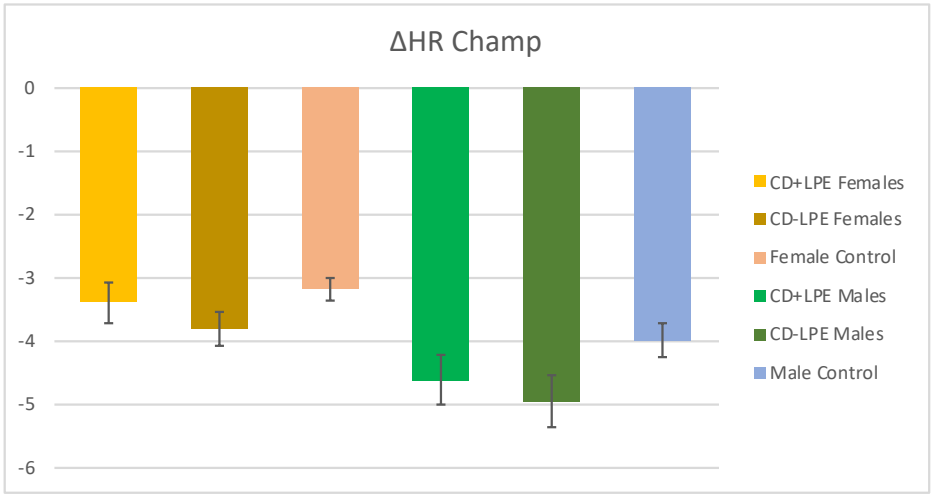

Figure 3. Heart Rate (HR) change during film clip The Champ film clip.
Error bars represent SE; LPE = Limited Prosocial Emotions.

For the *Bear* there was no significant main effect of group for the HR response ($F(2,1398)=2.33$, $p=0.098$), or for the PEP response ($F(2,1289)=2.59$, $p=0.075$, $n_p^2=0.004$). Also, the group*sex interaction effect was not significant for both outcome measures. For the RSA response, however, we found a significant effect of group ($F(2,1330)=4.36$, $p=0.013$, $n_p^2=0.007$), with the CD-LPE subgroup showing a significantly larger increase in RSA than typically developing controls ($p=0.015$; see Figure 5). The group*sex interaction effect was not significant.

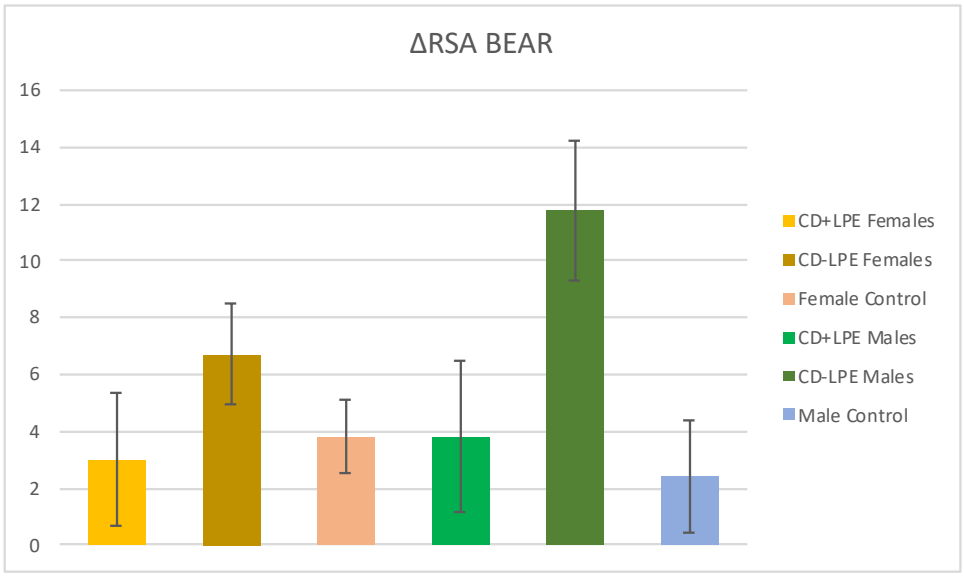

Figure 4. Respiratory Sinus Arrhythmia (RSA) change during the Bear film clip
Error bars represent SE; LPE = Limited Prosocial Emotions.

Second, we ran an ANCOVA to compare CD girls and boys with a comorbid internalizing disorder (CD+INT) to those without internalizing comorbidity (CD-INT) and to controls. There was no significant effect of group, nor a significant sex*group interaction effect for any of the psychophysiological measures in response to either of the two film clips.

Lastly, we compared the physiological response within the CD subtype with LPE, by comparing those with and without comorbid internalizing disorders. We ran an ANCOVA investigating the main effect of group (CD+LPE+INT versus CD+LPE-INT) and testing for sex*group interaction effects. Co-occurring LPE and internalizing comorbidity was more prevalent in girls (34.0%) than in boys (23.3%) (see table 1). There was no significant difference in HR, HRV or PEP reactivity between CD+LPE+INT and CD+LPE-INT for both film clips. The group*sex interaction effect was not significant.

Discussion

The aim of this study was to investigate the physiological correlates of emotion processing in a large sample of clinically diagnosed girls and boys with CD and sex-matched controls. We found a larger decrease in heart rate during sad film clips in children and adolescents with CD as compared to typically developing controls, and

this effect was similar in girls and boys. This was mainly driven by a larger increase in parasympathetic activity. In other words, we found hyper-reactivity of HR and HRV to sadness in CD. Furthermore, we found indications that physiological correlates of emotion processing are mainly altered or dysregulated in CD without Limited Prosocial Emotions (CD-LPE): they showed the largest decrease in HR and largest increase in HRV. Contrary to predictions, we did not find differences in physiological responses between CD individuals with and without internalizing comorbidity. All our findings were similar for boys and girls. Thus, this study did not provide evidence for sex differences in the physiological underpinnings of emotion processing in CD. Effect sizes of all findings were small, indicating that HR and HRV responding differed only slightly between (sub)groups. Furthermore, this study showed that the findings for HR reactivity were abolished when smoking was added as a covariate. It is, however, debatable whether smoking should be used as a covariate as there was a striking difference between the groups in rates of smoking (49.7% in CD versus 6.6% in controls).

The observed physiological hyper-reactivity in CD contrasts with previous findings in the literature. Previous studies assessing physiological emotion processing in CD and related conditions have used a variety of paradigms and stimuli, which may explain why our findings contrast other work. To our knowledge, only two studies have investigated HR reactivity to sadness inducing film clips in DBD (CD or ODD). One study presented a diminished HR response in DBD (De Wied, Boxtel et al. 2009), and the other study also presented a diminished HR response, but only in the DBD+LPE subgroup (de Wied, van Boxtel et al. 2012). Consistent with our study, the latter showed that the DBD-LPE subgroup showed the largest HR response. However, this result was not statistically significant. Of note, the two studies mentioned had small samples sizes (22 DBD in (De Wied, Boxtel et al. 2009), 31 DBD in (de Wied, van Boxtel et al. 2012). Alternatively, the film clips we have used have resonated more with children and adolescents with CD, since they are more likely to have experienced childhood adversities such as parental separation or bereavement. The impact of stimuli might be stronger for those who have experienced similar situations themselves. We did not ask participants whether they had experienced similar situations and thus were not able to check this hypothesis.

Our finding on parasympathetic nervous system (PNS) responding to emotion induction is in line with the literature presenting increased HRV responses in youth with externalizing disorders (Beauchaine and Thayer

2015, Beauchaine, Bell et al. 2019) . It is suggested that aberrant HRV responding reflects inefficient control of the mPFC over the amygdala (Thayer and Lane 2009), which may result in non-adaptive emotional responses such as aggression. As for the sympathetic nervous system (SNS) response, we did not find differences between CD and typically developing controls. Previous studies have demonstrated decreased SNS responding in relation to antisocial behavior (Lorber 2004, Fanti 2018, Fanti, Eisenbarth et al. 2019). Most of these studies, however, have used electrodermal activity (EDA) as a measure for SNS functioning. The cardiac SNS measure PEP has been studied mostly in the context of reward processing. As such, we cannot conclude whether our results contradict previous work on SNS responding in antisocial behavior, or whether they indicate that PEP does not index emotion processing. To further investigate this, future studies should include both PEP and EDA when using emotion induction tasks.

Although generally boys displayed larger physiological responses than girls, group comparisons were similar for girls and boys. Thus, this study suggests no sex differences in the physiological correlates of emotion processing in CD. Previous studies have demonstrated sex differences, though: Crozier and colleagues (2008) and Eisenberg and colleagues (1996) found a positive association between HR responses and antisocial behavior in boys, but not in girls. Similarly, Beauchaine, Hong and Marsh (2008) found that aggression was inversely correlated with PEP reactivity in boys, but not in girls. These studies differ from the current study on multiple aspects, however. The first two studies used community samples, the subjects in the Eisenberg study were only 7,5 years old, Beauchaine and colleagues used a reward paradigm, and, the sample sizes of all three studies were much smaller than ours. Therefore, we cannot conclude whether the current findings refute earlier indications for sex differences, or that the current findings are specific to a clinical sample of CD children and adolescents in the context of sadness induction. To further the knowledge on sex differences/similarities in the physiological underpinning of emotion processing in CD, we recommend future studies to include a clinical sample comprising both girls and boys.

In contrast to expectations, we did not find impaired emotion processing in CD children and adolescents with LPE (CD+LPE). Still, they did not show the same hyper-reactivity that we observed in CD without LPE (CD-LPE). Hyper-reactivity has been found before in youth without LPE (Frick 2016). This could suggest an

increased 'emotional sensitivity', i.e. increased physiological responses to emotional stimuli. Alternatively, this could point to impaired emotion regulation, i.e. diminished abilities to control (physiological) responses to emotional stimuli, as demonstrated in the study of Raschle et al., (2019). Furthermore, it should be noted that we have assessed LPE via self-report. This may have affected our findings and might explain the relatively high percentage of LPE that we found in the control group.

Moreover, contrasting our expectations, we did not find physiological hyper-reactivity in CD with internalizing comorbidity (CD+INT). CD with/without INT did not differ on any of the physiological measures. Our findings could indicate a shared underlying mechanism in CD with and without internalizing comorbidity. Irritability is such a mechanism that has been identified to underlie different clinical phenotypes. Irritability characterizes both anxiety and ODD, and as these conditions often co-occur, irritability could be the common underlying trait (Leibenluft 2017). This illustrates a similar neurobiological pattern underlying different clinical phenotypes. Thus, despite the expression of a different symptom set in CD with and without internalizing disorders, the similar physiological reactivity that we found could suggest a shared mechanism underlying these different phenotypes. Hence, physiological hyper-reactivity to sadness seems to characterize both CD with and without internalizing comorbidity.

Lastly, we distinguished between the CD subtype with LPE between those presenting with and without co-occurring internalizing comorbidity (CD+LPE+INT versus CD+LPE-INT). We did not find differences in physiological responding between these groups. Studies that found evidence for a distinction between these subtypes have mostly used behavioral measures, such as aggression (Kimonis, Skeem et al. 2011, Fanti, Demetriou et al. 2013). There are two studies that have investigated neurobiological underpinnings of this subtyping approach. They found differences in startle potentiation between high/low anxiety subgroups of LPE youth (Kimonis, Fanti et al. 2017) and between high/low anxiety subgroups of female psychopathic offenders (Sutton, Vitale et al. 2002). However, similar to our findings, the latter study demonstrated that autonomic measures (HR and EDA) did not differentiate between these subgroups. Thus, more research is warranted to further investigate the neurobiology underlying subtypes of CD with LPE with versus without comorbid INT.

This study demonstrated that adding smoking to the analyses substantially attenuated the group-effect observed for the HR response. Given the uneven distribution of rates of smoking in CD versus controls, it should be considered whether smoking is a characteristic of CD, and including smoking as a covariate is 'overcorrection'. It is problematic to control for a covariate that is not independent of the grouping variable because of the shared variance between the grouping variable and the covariate (for instance see (Miller and Chapman 2001, Lynam, Hoyle et al. 2006)). Controlling for smoking, as done in this study, removes the variance shared with group (CD/control) and thereby potentially removes a substantial component of the variable group. Evidence for shared variance between smoking and CD comes in the first place from studies demonstrating that the prevalence of smoking is elevated in adults and adolescents with psychiatric disorders. More specifically, Brown, Lewinsohn, Seeley, and Wagner (1996) demonstrated that smoking was strongest related to disruptive behavior disorders (ODD and CD) after controlling for other psychiatric disorders. Furthermore, there is evidence for a shared neurobiological basis of smoking behavior and psychiatric disorders: nicotine acethylcholine receptors are involved in crucial neural pathways (for instance the so-called reward system), aberrant serotonin levels are associated with psychiatric disorders as well as with smoking, and certain genetic deficits have been found that relate to both psychiatric disorders and smoking (Dome, Lazary et al. 2010). Others propose that third factors (for instance risk taking, impulsivity, low self-esteem) serve as a mediator between smoking and psychiatric disorder (Hughes 2008). Such evidence indicates a shared mechanism underlying smoking and CD, and would favor the hypothesis that controlling for smoking is 'overcorrection'. Furthermore, the multiple linear regression that we performed demonstrated that there is a significant drop in the regression coefficient of group when smoking is added. This accounts for both film clips, however, the decrease in β differs significantly for the film clips; there is a 20% decrease for film clip *The Champ*, whereas the β decreases almost 60% for film clip *Bear*. A purely physiological effect of smoking assumes a similar reduction in β for both film clips. The unequal β-reduction found here reduces the likelihood of smoking as an independent covariate, and suggests that smoking associates with characteristics that affect emotion processing. However, we cannot make definite inferences about the exact role of smoking in the psychophysiology of CD.

Therefore, we recommend that future studies assess tobacco smoking and analyze its impact on ANS parameters so that this association can be further investigated.

Strengths and limitations

To our knowledge, this study comprises the largest dataset of clinically-diagnosed girls and boys with CD in which the physiological underpinnings of emotion processing were investigated in a standardized and validated manner. We also tested several approaches to subtyping CD, including comparing those with and without the LPE specifier, and deliberately tested for sex differences in the relationship between CD and psychophysiological reactivity to emotional stimuli. Lastly, we used ecologically valid, dynamic stimuli that are more likely to induce emotional reactions than the static images that are typically used in this area (e.g., pictures from the International Affective Pictures System). Despite its strengths, there are several limitations to this study that should be considered. First, we only induced one emotion (sadness) in our experiment. We used sadness since it elicits a consistent psychophysiological response (*conservation withdrawal response*), i.e. a decrease in arousal (Kreibig 2010). Other emotions elicit different physiological responses, for instance, anger and fear evoke an increase in arousal to activate the individual to enable a fight/flight response. These 'activating emotions' can be used to detect different psychophysiological response tendencies, which could be more relevant for detecting SNS related deficiencies. Furthermore, our results cannot be interpreted as indexing general emotional response deficits, and its implications are limited to sadness-inducing stimuli. For a full understanding emotion processing in CD, we suggest that future studies include stimuli of several emotions.

In conclusion, we found physiological hyper-reactivity to an emotion evocation procedure in both girls and boys with CD, especially in those without LPE. Increased emotional reactivity may index deficits in emotion regulation strategies, or increased emotional sensitivity, which, in turn, requires strong emotion regulation strategies. Therefore, we want to highlight the importance of targeting emotion regulation strategies in interventions for CD.

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SUPPLEMENTS

APPENDIX A

Psychophysiological measures during baseline and target scene film clips

	FEMALE				MALE			
	CASE (N=417)		CONTROL (N=496)		CASE (N=261)		CONTROL (N=253)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Baseline preceding Bear								
HR (bpm)	80,38	11,15	79,45	10,67	79,74	12,09	77,26	12,09
RSA (msec)	81,10	44,50	82,95	40,55	82,75	46,42	84,95	47,00
PEP (msec)	103,97	18,16	101,65	16,87	96,40	21,06	96,15	20,07
Target scene Bear								
HR (bpm)	75,53	11,07	75,59	10,66	74,28	12,51	72,39	11,80
RSA (msec)	85,36	45,82	87,84	44,68	91,48	51,99	87,03	46,17
PEP (msec)	103,89	18,29	101,12	17,30	97,56	21,58	95,92	20,03
Baseline preceding Champ								
HR (bpm)	80,38	11,10	79,75	10,69	80,33	11,83	77,61	11,50
RSA (msec)	79,69	41,63	83,01	41,43	82,66	44,87	82,15	41,99
PEP (msec)	103,68	17,61	101,77	16,91	97,34	20,98	95,36	20,11
Target scene Champ								
HR (bpm)	76,74	11,45	76,74	10,57	75,48	12,36	73,59	11,92
RSA (msec)	81,26	42,84	81,58	41,18	83,03	45,97	77,21	38,83

PEP (msec)	104,72	18,21	102,81	17,32	98,40	21,83	96,86	20,35

Note: HR = heart rate, RSA = respiratory sinus arrhythmia, PEP = pre-ejection period. N may differ from N in table 2 since outliers for the physiological response are not identical to outliers for baseline or target scene.

APPENDIX B

Correlation between potential covariates and psychophysiological measures during baseline, during the target scene of the film clip, and the response

	Age	Medication[1] (y/n)	Sports (h/wk)	Smoking (cigarettes/ day)	BMI
HR Baseline Champ	-,282**	,139**	-,060*	-0,017	-0,055
HR Target CHamp	-,288**	,159**	-0,031	-0,041	-,063*
ΔHR Champ	-0.021	-0.004	0.040	-0.075**	-0.010
PEP Baseline Champ	,349**	-0,001	-0,058	,116**	,159**
PEP Target Champ	,348**	-0,02	-0,045	,127**	,156**
ΔPEP Champ	0.014	-0.036	0.004	-0.035	0.007
RSA Baseline Champ	-,087**	-,068*	0,034	-0,054	-,069*
RSA Target Champ	-,087**	-,056*	0,012	-0,031	0,025
ΔRSA Champ	-0.018	0.009	-0.045	0.010	0.096**
HR Baseline Bear	-,267**	,145**	-0,055	-0,015	-,058*
HR Target Bear	-,292**	,134**	-,068*	-0,052	-0,041
ΔHR Bear	-0.059*	-0.017	0.040	-0.070*	-0.037

PEP Baseline Bear	,341**	-0,014	-,063*	,122**	,168**
PEP Target Bear	,369**	-0,017	-0,054	,142**	,163**
ΔPEP Bear	0.112**	-0.015	0.011	0.033	0.024
RSA Baseline Bear	-,103**	-0,043	0,031	-0,035	-0,05
RSA Target Bear	-,091**	-0,036	0,043	-,057*	0,008
ΔRSA Bear	-0.015	0.023	-0.010	-0.033	0.049

Note: HR = heart rate, RSA = respiratory sinus arrhythmia, PEP = pre-ejection period.

* significant at the 0.05 level, ** significant at the 0.01 level

[1] *only* medication intake with potential effect on heart activity is considered

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Chapter 5 General Discussion

The main aim of this thesis was to further knowledge about how maternal mental strain affects child development and maternal parenting behavior. The first aim was to investigate how mothers' own psychological problems affect children's internalizing and externalizing problems, and which role parenting behavior plays in this context (Chapter 2). Second, we investigated the concept of expressed emotion, especially maternal expressed criticism in the context of mother-child interaction, maternal mental strain and child outcome (Chapter 3). Because of methodological difficulties and a small sample size, a further investigation of how child adjustment is affected by interactional characteristics on a psychophysiological basis - using cortisol as a long-term stress marker and ANS reactivity to a stress-inducing task as a measure of stress reactivity competencies – could not be pursued. However, ANS reactivity in children and adolescents was the target of investigation in our third study. In a large European multicenter case-control study (FemNAT - CD - Neurobiology and Treatment of Adolescent Female Conduct Disorder: The Central Role of Emotion Processing), boys and girls aged 9 to 18 affected by conduct disorder were compared to healthy controls regarding their physiological emotion processing in the face of sadness-inducing film clips.

In Chapter 2 we found significant associations between maternal mental strain, and externalizing and internalizing behavior problems in children. In particular, mothers with high levels of anxiety and depression symptoms had children with significantly higher levels of emotional, social and behavioral problems. These findings are in line with the study results of many research projects discussed in the literature (Agnafors et al., 2016; Breaux, Harvey, & Lugo-Candelas, 2014).

Moreover, we found mothers struggling with mental strain to be less sensitive during mother-child interaction. They were less responsive to the needs of their children as well as to their displays of emotion. Moreover, we found mothers with higher levels of anxiety and depression to be less structuring and supportive when interacting with their children. Maternal structuring behavior in terms of rule-setting and adequate support and guidance is essential for successful dyadic interactions and healthy child development. In addition, positive

child interactional qualities were less pronounced when mothers showed higher levels of mental strain, leading to less responsiveness in children and an overall reduction in harmony and warmth during interactions. Kluczniok et al. (2016) found similar results in mothers and their children aged from 5 to 12. Mothers with depression in remission showed less emotional availability during interactional tasks in conjunction with less maternal sensitivity, less structuring behavior and more hostility. In line with these results, findings by Silvia Schneider et al. (2009) showed more maternal criticism and less sensitivity in mothers with a current panic disorder. In contrast to other study results, our findings showed global maternal mental strain, but not quality of interaction, to be related to externalizing symptoms in children. Study results from Van Doorn et al. (2016) are similar, finding no associations between maternal parenting behavior and children's maladjustment. In contrast, Villodas et al. (2018) found depression in mothers to be related to more harsh and negative parenting practices, which were associated with more externalizing behavior in children. Similarly, Stormshak et al. (2000) found more negative and punishing parenting in mothers of children with current ADHD or a conduct disorder.

Regarding internalizing symptoms in children in connection with mother-child interaction, results differed from those found regarding externalizing symptoms. In the case of internalizing symptomology, we found maternal interaction behavior (maternal sensitivity, maternal intrusive behavior and overall interactional harmony and warmth) to reliably predict children's internalizing problems such as withdrawal, depression and social fears. This result supports the idea of a transgenerational inheritance phenomenon regarding anxiety disorders as described by Murray et al. (2008). Murray and his colleagues could provide substantial evidence that a mother's behavior in the face of an unfamiliar situation (meeting new people) forecasts child behavior in the same situation in terms of model learning. If mothers showed withdrawal behavior or anxiety, children also did.

In Chapter 3, we focused on potential associations between maternal criticism and children's adjustment, and on the relationship between criticism and mother-child interaction. We found higher maternal criticism rates to be related to more externalizing behavior problems in children. Moreover, we found higher criticism rates in mothers suffering from mental strain. These findings are supported by similar findings in literature evaluating the impact of maternal depression on expressed criticism. Tompson et al. (2010) found depressed mothers to express more criticism towards their children than non-depressed mothers did. In contrast to a majority of

studies, ours did not exclusively focus on maternal depression relating to criticism, but included a whole range of other psychiatric symptoms in mothers and found that, except for the subscales of somatization and phobia, all other maternal psychiatric problems accounted for as much criticism in mothers as depression did.

A second aim of our study was to investigate the association between maternal expressed criticism and internalizing and externalizing behavior problems in children. In this context, we found similar results to those of prior studies. Gathering expressed emotion speech samples from 100 mothers and their school-aged sons, Psychogiou et al. (2007) found positive correlations between maternal expressed criticism and child ADHD, conduct problems and emotional maladjustment in children. Likewise, using a monozygotic-twin study, Caspi et al. (2004) could find that the twin exposed to more negativity and less maternal warmth displayed more antisocial behavior, suggesting that maternal emotional attitudes toward a child may play a crucial causal role in the development of antisocial behavior. In our study, children of mothers expressing higher rates of criticism towards their children showed a higher degree of behavioral, emotional and social impairment. Interestingly, the association between high criticism and internalizing problems in children showed more pronounced effects than the link between criticism and externalizing behavior problems.

Concerning the associations between maternal criticism and mother-child interaction, we found elevated maternal expressed criticism to be related especially to child interactional qualities, finding less responsiveness in children with mothers expressing higher rates of criticism. This interesting result is supported by the findings of McCarty et al. (2004), who found parents high in expressed criticism to act less responsively and display more disgust, harshness, negativity, and antagonism during interaction with their children.

Furthermore, we found a trend that mothers who express higher rates of criticism tend to act less sensitively in mother-child interactions. Whereas links between maternal criticism, and maternal sensitivity and child responsiveness were found, no association between criticism and maternal structuring behavior, intrusiveness, or overall interactional harmony and warmth was found.

In the light of findings by Gravener et al. (2012), a further aim of our study was to investigate whether the link between maternal mental strain and children's maladjustment might be mediated by maternal expressed

criticism. Whereas Gravener et al. (2012) found maternal criticism to mediate the link between maternal mental strain and both internalizing and externalizing symptoms in children, Denise R Nelson et al. (2003) found maternal criticism to mediate the link between maternal mental strain and only externalizing but not internalizing problems in adolescents. Our hypothesis regarding this mediation model was supported regarding externalizing behavior problems, but not internalizing impairment in children. Consequently, in the light of our results, parenting qualities seem to play a more pronounced role regarding internalizing problems in children, whereas maternal expressed criticism may account for externalizing problem behavior in children.

In Chapter 3 we focused on emotion processing deficits in adolescent boys and girls with a conduct disorder using ANS response to a sadness-evoking stimulus as a psychophysiological measurement of emotion processing. Kreibig (2010) reviewed autonomic nervous system activity in emotion processing in detail, finding sadness-evoking film clips to consistently elicit a psychophysiological response in various populations while eliciting a decrease in heart rate, an increase in RSA (PNS) and longer PEPs in terms of lower SNS activity. In this regard, we used a large clinical sample with diagnosed CD and comorbid disorders as well as a large sample of typically developing controls and compared them in terms of their emotional reactivity to sad film clips. As previous study results and literature suggest, we expected to find different emotional reactivity patterns in CD children and adolescents depending on accompanied comorbidity. For this purpose, we classified the CD sample into CD only, CD+INT, CD+LPE, CD+LPE+INT subgroups and compared them with one another and with controls. Furthermore, as pointed out before, most studies on emotion processing in CD have focused on boys, mainly because of the higher prevalence of CD in boys. However, the prevalence of CD in girls has increased in recent years, showing similar adverse developmental effects of CD in girls to those in boys (e.g. financial problems, substance abuse, mental and physical health problems, delinquency, etc.) (Schaeffer, 2006 #236). Additionally, there is evidence that boys and girls differ regarding their psychophysiological emotion processing, although findings are conflicting. Whereas Oldenhof et al. (2018) as well as other studies (Fairchild et al., 2010; Portnoy & Farrington, 2015) could not find differences in emotion processing between boys and girls, the results of Gur and Gur (2016) as well as those of S Schneider et al. (2011) do suggest neurobiological sex differences in CD adolescents. Furthermore, Tielbeek et al. (2017) found

sex specific correlates of CD in youths. Likewise, other studies have provided indices of sex differences in ANS reactivity (Beauchaine, Hong, & Marsh, 2008; Zhang et al., 2014) as well as sex differences using neuroimaging measures (Smaragdi et al., 2017). Regarding CD subtypes, literature suggests that the CD+INT subgroup is characterized by hyper-arousal due to high levels of fearfulness, whereas the CD+LPE subgroup is characterized by under-arousal due to fearlessness. Likewise, we expected the CD+INT group to exhibit the overall highest ANS response to the sad stimuli, whereas the CD subgroup with comorbid LPE (CD+LPE) was expected to show the lowest emotional reactivity to sad emotion evocation. Additionally, since CD in girls is assumed to be more frequently accompanied by comorbid internalizing impairment, we hypothesized aberrant ANS response to be more pronounced in CD girls than in CD boys.

As expected, we found aberrant heart rate reactivity in CD adolescents compared to healthy controls, with CD adolescents showing a larger decrease in their heart rate from baseline measurement to the target sadness-evoking scene, indicating impaired emotion processing in CD boys and girls. The larger HR reactivity in CD children and adolescents compared to healthy controls contrasts with the findings of current literature, with most study results indicating aberrant emotion processing in the form of smaller reactivity in CD children. For example, De Wied et al. (2009) found a lower HR reduction in response to sad stimuli in disruptive behavior disordered (DBD) adolescents. A further study by de Wied et al. (2012) again showed reduced HR reactivity in DBD adolescents, but only in the subtype DBD+LPE. It might be of note that de Wied et al. did no DBD-subtyping in their study in 2009. This seems to be an important factor regarding CD heterogeneity. Moreover, sample size was small in both studies. Schoorl et al. (2016) found no differences regarding HR, HRV and SCL stress reactivity between ODD/CD boys and healthy controls in a sample of 66 ODD/CD and 36 non-clinical boys (aged 8–12). However, hierarchical regressions showed different physiological profiles in subgroups of boys with ODD/CD based on their type of aggression. A pattern of high baseline HR and SCL, but low stress HRV was associated with reactive aggression, whereas the opposite physiological pattern (low HR, low stress SCL, high stress HRV) was related to proactive aggression. Although Schoorl et al. (2016) used a frustration-inducing stress task and not a sad stimulus to evoke emotion processing; their findings might highlight the need to address CD heterogeneity regarding different types of aggression.

Our results of more pronounced HR and HRV responses to the sad stimulus in CD children and adolescents support the previous findings of Beauchaine et al. (2019) claiming emotion-processing deficits to be more related to aberrant parasympathetic (PNS) responding than to lower sympathetic activity. As mentioned in Chapter 1, HRV is described in literature as an index of medial Prefrontal Cortex (mPFC) functioning which is perceived to play an important role in emotional processing (Thayer & Lane, 2009) by having an inhibitory influence on the amygdala, which generates fight/flight reactions to stimuli, which in turn play a crucial role in effortful control (Kanske & Kotz, 2011). In this regard, high HRV indicates effective emotional functioning. Beauchaine et al. (2019) tried to explain their findings regarding aberrant high HRV suggesting that parasympathetic over-arousal in response to stressful stimuli lead to an increased subjective feeling of overwhelming emotions, which in turn elicit higher rates of aggressive behavior. In contrast to Beauchaine et al. (2019), Fanti et al. (2019) could not find any indications of an association between higher HRV reactivity and the presence of a CD in patients compared to healthy controls.

We could not find aberrant SNS reactivity to the sad stimulus in CD children and adolescents compared to healthy controls, as PEP measures did not differ between the groups. Some studies did find aberrant PEP reactivity in CD adolescents, but they either used electrodermal activity (EDA) to measure SNS reactivity (Fanti, 2018; Fanti et al., 2019) or measured PEP reactivity in connection with a reward (e.g. non-emotional) task (Beauchaine, 2012), so that results are difficult to compare to ours. Concerning our results, PEP did not figure as an index of emotion processing in CD boys and girls.

In a second step, we took a closer look at the CD subtypes, firstly comparing CD with comorbid internalizing problems to the CD-only sample. We could not find any group differences comparing both samples, in contrast to our hypothesis, but supporting the idea of a common underlying mechanism in both groups. In this context, Leibenluft (2017) described the concept of irritability as a potential common trait/clinical problem in various clinical populations including CD, ODD and Disruptive Mood Dysregulation Disorder (DMDD). It is assumed that irritability may result from aberrant response to frustration and threat. In studies using social stimuli to trigger reactivity, irritability was found to be strongly associated with anxiety, leading to hyper-reactivity. Moreover, irritability predicted aberrant reward learning, deficits in cognitive control and attention, and hyper-

reactivity to frustration. Further studies found similar insights, assuming the aggressive behavior of the CD+INT subgroup to be characterized by higher rates of fearfulness, resulting in hyper-arousal as a reaction to emotional stimuli (Dierckx et al., 2014; Schoorl et al., 2016). Thus, aberrant psychophysiological emotion processing seems to be similarly pronounced in CD both with and without internalizing comorbidity.

In a further step, we focused on the CD subtype including LPE (CD+LPE), comparing it to the CD subgroup without LPE (CD-LPE) and controls. As assumed, we found the highest ANS reactivity in the CD-LPE subgroup, supporting the hyper-arousal, fearfulness, emotionally overwhelmed assumption. This is in line with the findings of a previous study (Frick, 2016 #246). However, in contrast to what we expected, we found the lowest emotion reactivity in the controls, not in the CD+LPE subgroup as expected. One possible explanation for this surprising result might lie in the way we assigned adolescents to the LPE matching group. Participants in our study were considered to meet the criteria for the LPE specifier (CD+LPE) if two or more CU traits were endorsed to threshold. A participant met the criteria for one of the CU traits (lack of emotion, callousness, lack of remorse) when he/she reported that at least one item out of five on the corresponding subscale applied very well to him/her. It might be that the assigning method chosen was too broad, so that LPE might not have sufficiently well defined, leading to an over-recruitment, with a consequent effect on the data analysis.

On the other hand, in line with our findings, the study results of Jambroes et al. (2016) only found a limited usefulness of the LPE specifier and CU traits in differentiating between individuals with CD. Colins et al. (2018) suggest a multidimensional model to subtype CD, instead of a categorical subtyping method, to differentiate CU traits in CD patients in greater detail.

In addition, we analyzed possible differences in ANS reactivity in a further subtype concerning the presence of both comorbid internalizing and high LPE in CD children (CD+LPE+INT). Recent study findings suggest that the LPE index and internalizing comorbidity can occur concurrently in CD youth. Again, this combination seems to be more prominent in girls than in boys (Euler et al., 2015). Study results suggest that LPE in CD youth, accompanied by high levels of anxiety (CD+LPE+INT), leads to hyper-arousal in response to stress-evoking tasks, as opposed to the assumed hypo-arousal in the subgroup with exclusive LPE (CD+LPE-INT) (Fanti, 2018; Kahn, Frick, Youngstrom, Findling, & Youngstrom, 2012; Kimonis, Frick, Cauffman,

Goldweber, & Skeem, 2012). We found no differences in physiological responding between the CD+LPE+INT and the CD+LPE-INT samples. Of note, studies mentioned above which found evidence of differences in both subgroups used either startle potentiation as a physiological responding measurement (Kimonis et al., 2012), which cannot be compared to our findings, or behavioral and not physiological measurements, such as aggression or antisocial behavior, to assign people to a subtype (Euler et al., 2015; Fanti, 2013). Sutton et al. (2002), however, found similar findings to ours, suggesting no differences in both subgroups concerning ANS measures (EDA and HR) in a sample of female psychopathic offenders.

Another major focus of our study was to scan our sample and CD-subtypes for possible sex differences regarding heart rate reactivity. Indeed, overall, boys displayed higher psychophysiological responses than girls, but comparisons did not reach significance. Thus, study results do not point out sex differences in psychophysiological responding to sadness-evoking stimuli. Literature and study results suggest that girls, based on biological differences, have overall a higher resting heart rate than boys and thus are assumed to be less frequently involved in disruptive and offending behaviors, or crime (Choy et al., 2017; Portnoy et al., 2014). In line with these findings, Portnoy and Farrington (2015) found reduced resting heart rates in girls with antisocial tendencies. When it comes to heart rate reactivity, results are less clear and rarer. Kelly et al. (2008) found no sex differences in heart rate reactivity in 62 healthy men and women while they were completing a standardized psychosocial stress challenge (i.e., the Trier Social Stress Test). In contrast, Beauchaine et al. (2008) found sex differences regarding cardiovascular reactivity in CD boys and girls, with boys showing decreased autonomic functioning as expected, but girls only exhibiting increased electrodermal responses, but no differences in cardiovascular reactivity compared to controls. Here, it seems important to note that that study design differed from ours, as it used a reward/ frustrating non-reward task to elicit reactivity. Heart rate reactivity to reward/non-reward might differ from heart rate reactivity to sadness-evoking tasks, targeting different emotional states. Fernández et al. (2012) investigated emotional reactivity (heart rate (HR) reactivity and skin conductance level (SCL) in 132 healthy adults after presenting them different emotion-evoking film-clips capable of evoking emotions of anger, fear, disgust, amusement, sadness, tenderness and a neutral state. They found women to display significantly higher SCL and HR responses to film-clips evoking sadness.

Overall, study results suggested that film-clips that evoked fear and anger induced psychophysiological activation more easily. In addition, Crozier et al. (2008) found positive associations between HR reactivity and antisocial behavior in boys, but not in girls. Here, sample size was small and they used a community sample, so that it remains unclear whether our results refute earlier findings or are specific to a clinical sample of CD youth with respect to sadness induction.

Similar to Prätzlich et al. (2018), we found smoking to be a significantly confounding factor regarding autonomic nervous functioning. Adding smoking as a covariate to the analyses attenuated the observed group effects regarding HR and HRV response substantially. To further analyze its influence, we added smoking, group status and the interaction between them as predictors to a stepwise regression using HR response as the outcome variable. Results indicated that smoking did not account for an effect modification on the association between group and HR response. However, we found smoking to be a significantly confounding factor on the association between group and HR response. Moreover, we found smoking to be significantly associated with group, especially in samples containing nearly 50% smokers opposed to only about 7% smokers in the controls. Consequently, because of substantial shared variance between smoking and the group variables, smoking does not appear to be an independent covariate but rather should be categorized as a group characteristic of cases (Miller & Chapman, 2001). Thus, adding smoking as a covariate leads to "overcorrection" for the effect of group. However, positive associations between smoking and disruptive, aggressive and overall antisocial behavior in girls and boys are well documented in literature (Talati, Keyes, & Hasin, 2016). In a longitudinal study of 1035 households Pagani et al. (2017) found that early exposure to tobacco smoke is a risk factor for later antisocial behavior in children. In addition, R. A. Brown et al. (1996) found that smoking is most strongly associated with disruptive behavior disorders, such as ODD and CD, after controlling for other psychiatric disorders. Results of multiple regression analyses including smoking as a covariate performed in relation to both film clips showed significant differences regarding the amount of the decrease in the regression coefficient (β) between film clip 1 (20% decrease) and film clip 2 (60% decrease). Such evidence indicates that controlling for smoking is an "overcorrection" and reduces the likelihood that smoking is considered as an independent

covariate. Still, our data can neither completely nor conclusively define the role of smoking in aberrant physiological responding in CD, so further studies are needed to build on our findings.

Study Limitations and Strengths

One reason why we could not find associations between maternal parenting behavior and externalizing behavior problems in children might be the lack of an explicit evaluation of maternal aggressive and punitive behaviors in our study design. There is also a chance that the observed sequence was too short or too structured, so that possible maternal intrusiveness and aggressive behavior could not be observed. It may be that a longer sequence of free play would have been more informative. Furthermore, the fact that mothers knew that they were being videotaped and that interactional qualities were being evaluated might have led to an inhibition of aggressive impulses in mothers.

Further methodological limitations need to be addressed. First, our study can provide current snapshots, but because of the cross-sectional study design, the evaluation of the causal direction of effects is not possible, so that only associations can be derived. Second, self-reports regarding maternal mental strain and mother-reports concerning children's externalizing and internalizing problems are both at risk of potential bias. Müller et al. (2014) highlighted mothers' own mental strain as a particular risk factor for bias when it comes to the evaluation of problem behavior in children. There is a potential risk that mothers evaluate their children lower or higher regarding their problem behavior depending on their own mental impairment. Similarly, it is conceivable that mothers tend to answer in a socially appropriate way regarding their own mental strain. This could be one explanation why maternal BSI scores did not reach above cut-off scores in our study sample. This represents another study limitation. Overall, the low-risk sample, also concerning reported child impairment, needs to be addressed as a study limitation. Apart from that, we did not explicitly include a clinical sample of mothers, so that we did not expect BSI scores to be pronounced. Nevertheless, we included child interaction qualities concerning our objective observational task, so that we can refute an exclusive maternal bias. This represents a strength of the study. Furthermore, we only included mothers' judgment and maternal interactional patterns regarding children's adjustment. The influence of fathers' parenting behavior and mental adjustment was not considered, although expressed emotion is defined as a family environment concept.

In addition, the small sample size represents one area of methodological limitation, excluding the possibility of more complex calculations of effects or subgroup comparisons. Moreover, a smaller sample size often leads to reduced power in statistical analysis, so that actual effects might not have shown up in analyses. However, despite the small sample size, we could find significant effects in terms of the relationships between EE, maternal mental strain, and child internalizing and externalizing behavior problems, highlighting the potential significance of EE in mother-child interactions and child outcome.

In addition, despite the small sample size, we did find important results concerning the relationships between maternal mental strain and child internalizing and externalizing problem behavior, as well as notable associations between parenting behavior and internalizing in children, supporting an etiologic framework concerning the development of internalizing disorders.

In terms of our study concerning HR emotion reactivity in CD boys and girls, a few limitations need to be addressed. First, the LPE group assignment might have been a little too broad, leading to some over-recruitment. Moreover, only self-reports on CU traits were surveyed, leaving potential for possible bias regarding socially desirable response patterns. The international and large sample size, and the inclusion of clinically diagnosed CD girls (making possible the investigation of sex differences in ANS response to sad stimuli), both figure as study strengths. Moreover, we incorporated sympathetic (SNS) as well as parasympathetic (PNS) measures to investigate ANS reactivity. Additionally, we added multiple covariates and possible confounding factors into our analysis, thus reducing the risk of bias in results. In this context, one study limitation is the lack of a sample survey of alcohol and substance use, which we did not account for in our study, but which is known to alter ANS activity (Silveri, Rogowska, McCaffrey, & Yurgelun-Todd, 2011). Moreover, we chose only one emotion to elicit a physiological ANS response in CD boys and girls. Although Kreibig (2010) could demonstrate sadness-evoking tasks to very consistently evoke psychophysiological reactions, more recent findings instead suggest using tasks eliciting anger or fear for this purpose. Anger and fear evoke an increase in arousal, not a decrease, as sadness does, and might therefore be more suitable for psychophysiological measurements of emotion reactivity, particularly SNS reactivity. In accordance with this, Fairchild et al. (2010) found emotion recognition deficits in CD youth in terms of anger and fear, but not

sadness. As a result, our results cannot be generalized to aberrant emotion processing in CD but are limited to insights regarding aberrant emotion processing in terms of sadness in CD.

Clinical Implications

In Chapter 1, we found maternal mental strain to be associated with more behavioral, emotional and social maladjustment in children. Despite a cross-sectional study design and thus a lack of causal effects, our results suggest early screening and rapid provision of treatment options for mothers presenting mental health problems to counteract the possible negative effects on children's adjustment. Moreover, results suggest low-threshold outpatient discharge services for at-risk mothers to prevent maternal mental strain from influencing mother-child interaction negatively. This may lead to reduced stress and a reduction in excessive demands on mothers, reducing the risk of potential mental health hazards in children, and may allow more positive mother-child interactions. Following a concept by Papoušek (2004), we suggest early preventive interventions such as early maternal screening procedures and outpatient discharge services to prevent children from developing mental disorders as a result of inadequate parental interaction behavior, rather than focusing on the children's disorders in isolation from potential parental maladjustment. In particular in young children, early preventive interventions considering parental mental strain and parenting behavior have been shown to influence children's adjustment in a positive way (Johnson, Seidenfeld, Izard, & Kobak, 2013). Moreover, intervention programs for parents lacking sensitivity, adequate structuring behavior or responsiveness targeting the enhancement of parenting qualities by reducing hostile or aggressive tendencies in parents, could reduce the risk that internalizing and externalizing problems will develop in children. Such parent-child-interaction therapies may supplement exclusive symptom-based treatment of child mental impairment.

In Chapter 2, we took a closer look at expressed emotion (EE) as a measure of family-environmental climate and its associations with maternal mental health, mother-child interaction and child outcome regarding internalizing and externalizing behavioral problems. Study results suggest the important role of parental criticism in relation to the development of child internalizing and externalizing symptoms and therefore seem to be of major importance regarding more tailored early intervention programs. Preventive interventions as well

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as treatment programs should target maternal criticism as one possible risk factor, which might contribute to negative parent-child interaction experiences and may increase the possibility of child maladjustment.

In Chapter 3, we found aberrant emotion processing in CD boys and girls aged 9 to 18. Impaired physiological ANS responding was specifically present in CD children and adolescents without Limited Prosocial Emotions (CD-LPE). In conclusion, our finding of increased physiological emotion responding in the CD sample may contribute to an explanation of increased emotional behavior problems in this population. Treatment strategies and interventions should target emotion regulation in CD to help young people cope in a more adaptive way when facing subjective feelings of being overwhelmed triggered by sad emotions and thereby effect symptom reduction.

Future Studies

Regarding the relationships between family risk factors such as maternal mental health, family climate, mother-child interactional patterns and child mental health as we investigated them in Chapter 2 and Chapter 3, some recommendations for future studies in this field should be considered. First, replications with sufficient sample size are strongly recommended. Additionally, it would be worth examining the impact of paternal expressed emotion and interaction behavior on child outcome to examine whether EE is a common experience of both parents or whether it should be evaluated separately. Moreover, future studies are required to incorporate multiple measures of child and parental psychopathology in order to reduce potential bias from parental reports only. Longitudinal studies with multiple, repeated measurements throughout childhood and adolescence would be essential to clarify the direction of effects and causal associations between variables.

In Chapter 3, we found smoking to be a significantly confounding variable in the association between group (CD vs. controls) and heart rate reactivity. Our study demonstrated that smoking changed the group effect on heart rate substantially. However, we could also demonstrate that, concerning our sample, the distribution of smoking was very uneven with smoking occurring up to four times more often in CD adolescents than in controls. This led us to the assumption that smoking might be more of a group characteristic than an independent covariate. Nevertheless, smoking is not often integrated as a covariate in studies concerning

emotional reactivity measures, especially not in studies of children and adolescents, and thus should be evaluated in more detail in future studies.

Moreover, we suggest that future studies use film-clips evoking different emotions (fear, anger, sadness, amusement) to clarify in terms of which emotions CD children and adolescents differ from healthy controls concerning their physiological response. In addition, we encourage future studies to use multiple informants to capture LPE in CD and not only rely on self-reports, so that possible bias from comorbid disorders or from tendencies to answer in a socially desirable manner can be eliminated.

In conclusion, the main aim of this thesis was to highlight links between family risk factors in early and middle childhood and child mental health, as well as potential impairment in emotion processing. Because of methodological limitations and the study design, we could not establish the path from early risk factors to emotion processing deficits in the same sample. For this reason, we strongly encourage future studies to incorporate family risk factors as mentioned in chapter 1 (e.g. home environment, mother-child interaction, SES, family atmosphere, parental criticism etc.) when investigating influences on psychophysiological emotion processing in children and adolescents, since literature strongly suggests that early life experiences as well as caregiver-child interactional patterns are involved in processes underlying the development of emotion processing in children (see chapter 1). We further recommend using longitudinal study designs with multiple measurements from childhood to adolescence in order to portray the development of emotion processing throughout childhood and adolescence more transparently.

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